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Kobayashi et al.

(10) **Patent No.: US 8,081,271 B2**
(45) **Date of Patent: Dec. 20, 2011**

(54) **BACKLIGHT APPARATUS AND LIQUID CRYSTAL DISPLAY APPARATUS**

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(73) Assignee: **Panasonic Corporation**, Osaka (JP)

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(22) Filed: **May 13, 2009**

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(30) **Foreign Application Priority Data**

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Aug. 22, 2008 (JP) 2008-214429
Aug. 22, 2008 (JP) 2008-214430

(51) **Int. Cl.**
G02F 1/1335 (2006.01)

(52) **U.S. Cl.** **349/64**; 349/68

(58) **Field of Classification Search** 349/64, 349/68

See application file for complete search history.

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* cited by examiner

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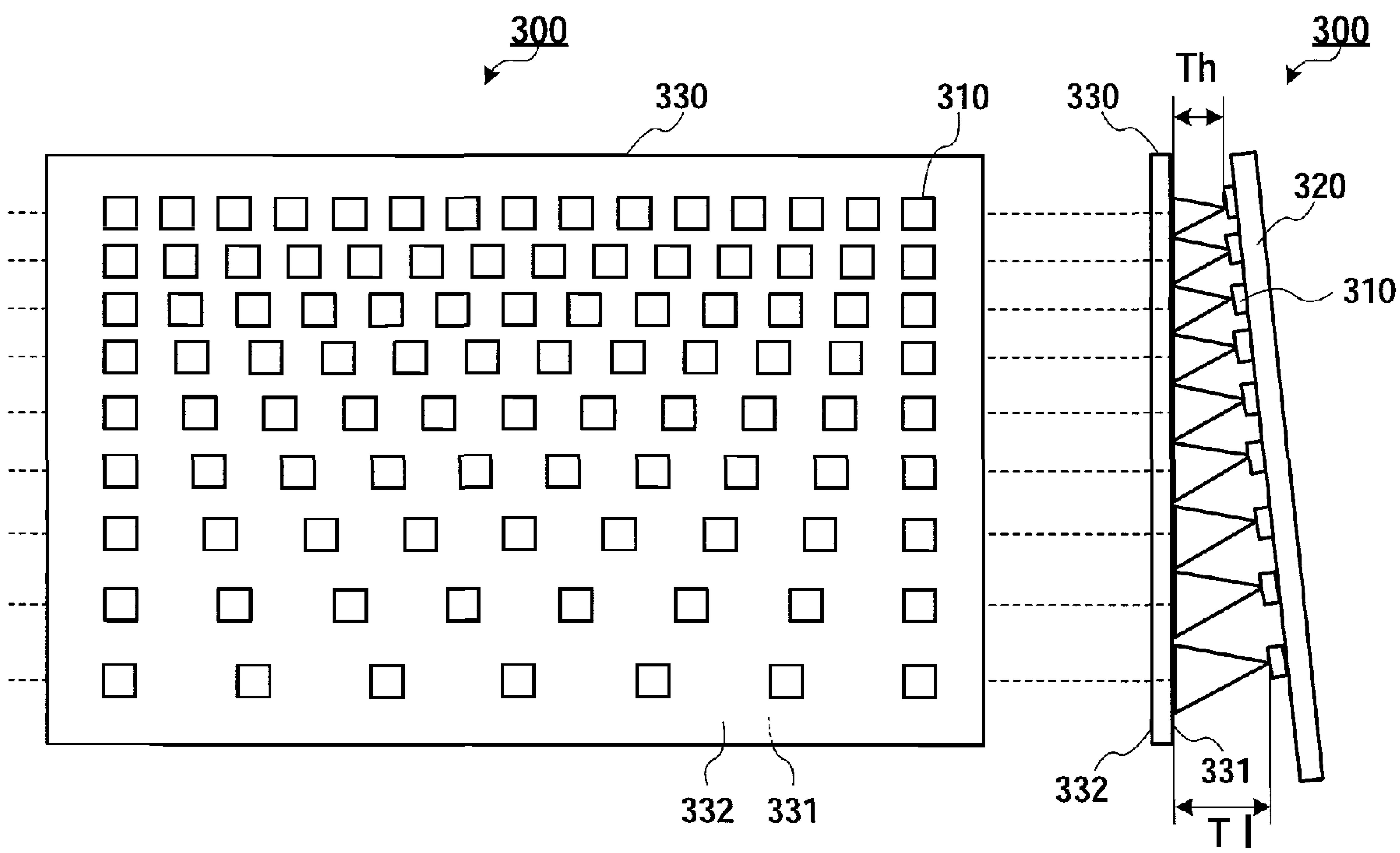
(74) *Attorney, Agent, or Firm* — Hamre, Schumann, Mueller & Larson, P.C.

(57) **ABSTRACT**

A backlight apparatus is provided that enables a balance of brightness to be maintained over the entire area of a display screen and long life to be achieved. The surface of substrate **130** is opposite the rear surface of liquid crystal panel **110**. LEDs **140** are placed on the surface of substrate **130**. LED drive circuits **150** supply LEDs **140** with a current that causes LEDs **140** to emit light that illuminates liquid crystal panel **110**. LED drive circuits **150** supply a lower current to LEDs **140** placed in an area having a higher ambient temperature within the surface area of substrate **130**.

2 Claims, 26 Drawing Sheets



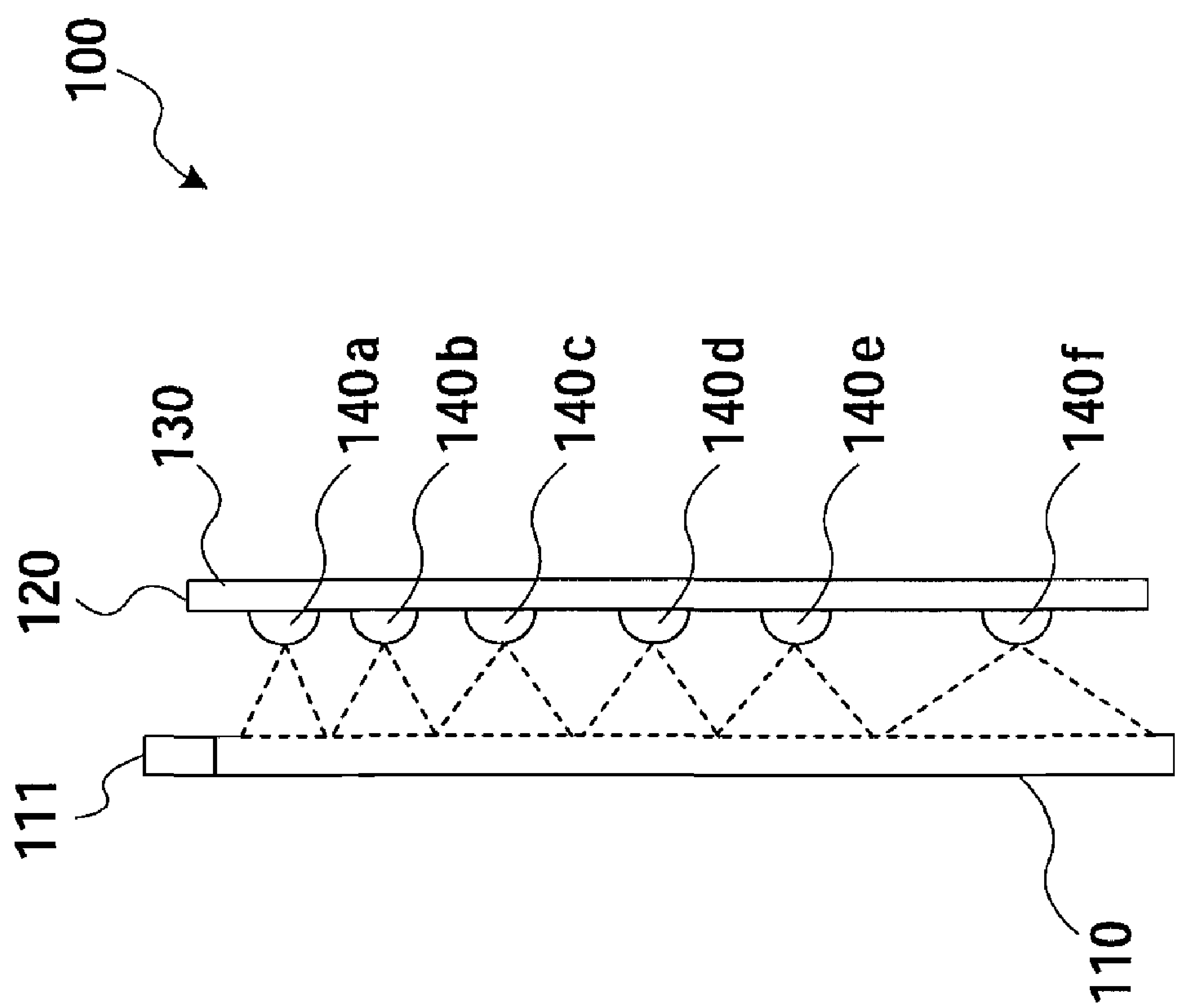


FIG.1

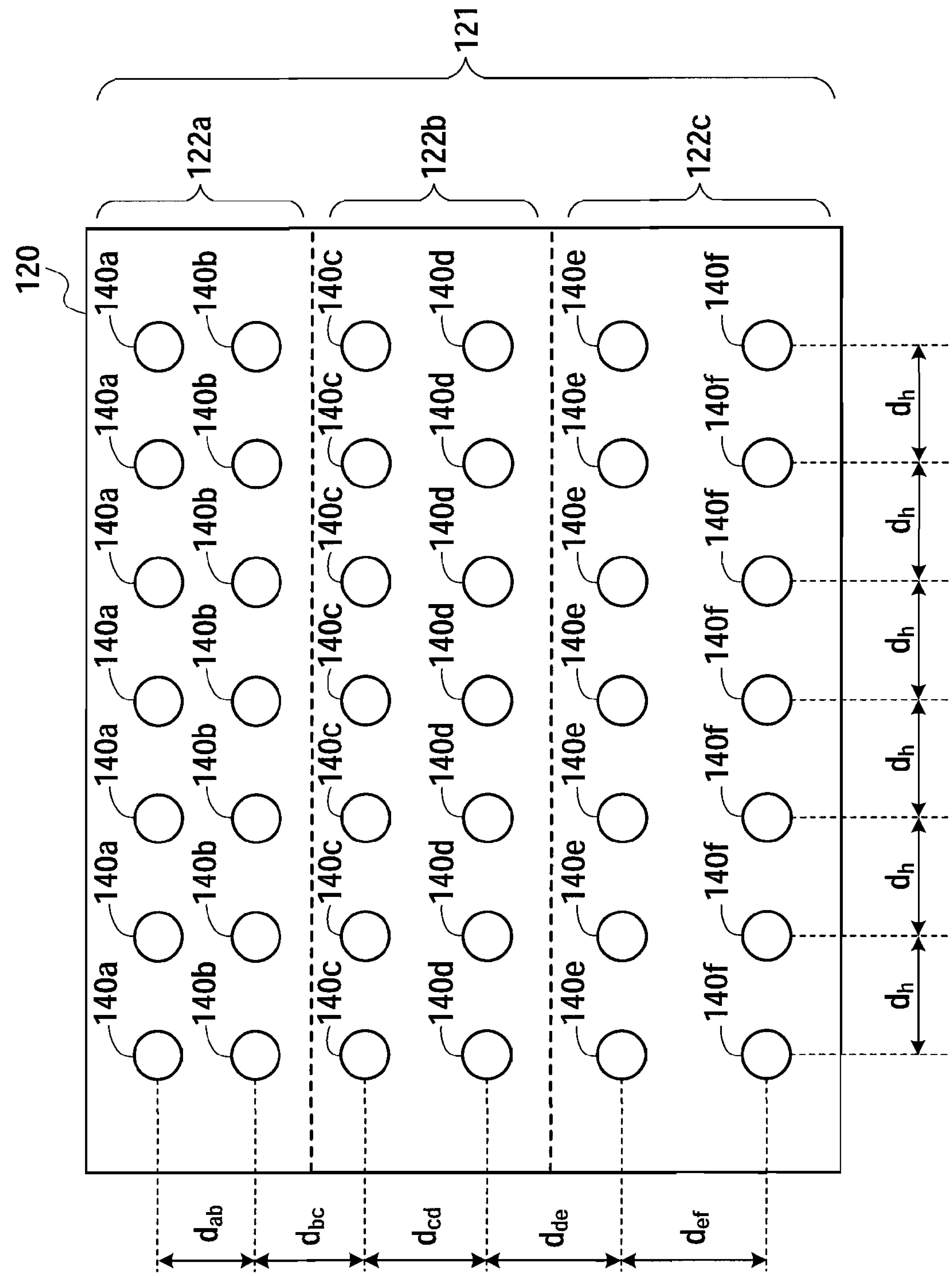

121
122a
122b
122c
120
140a
140b
140c
140d
140e
140f
d_h
d_{ab}
d_{bc}
d_{cd}
d_{de}
d_{ef}

FIG.2

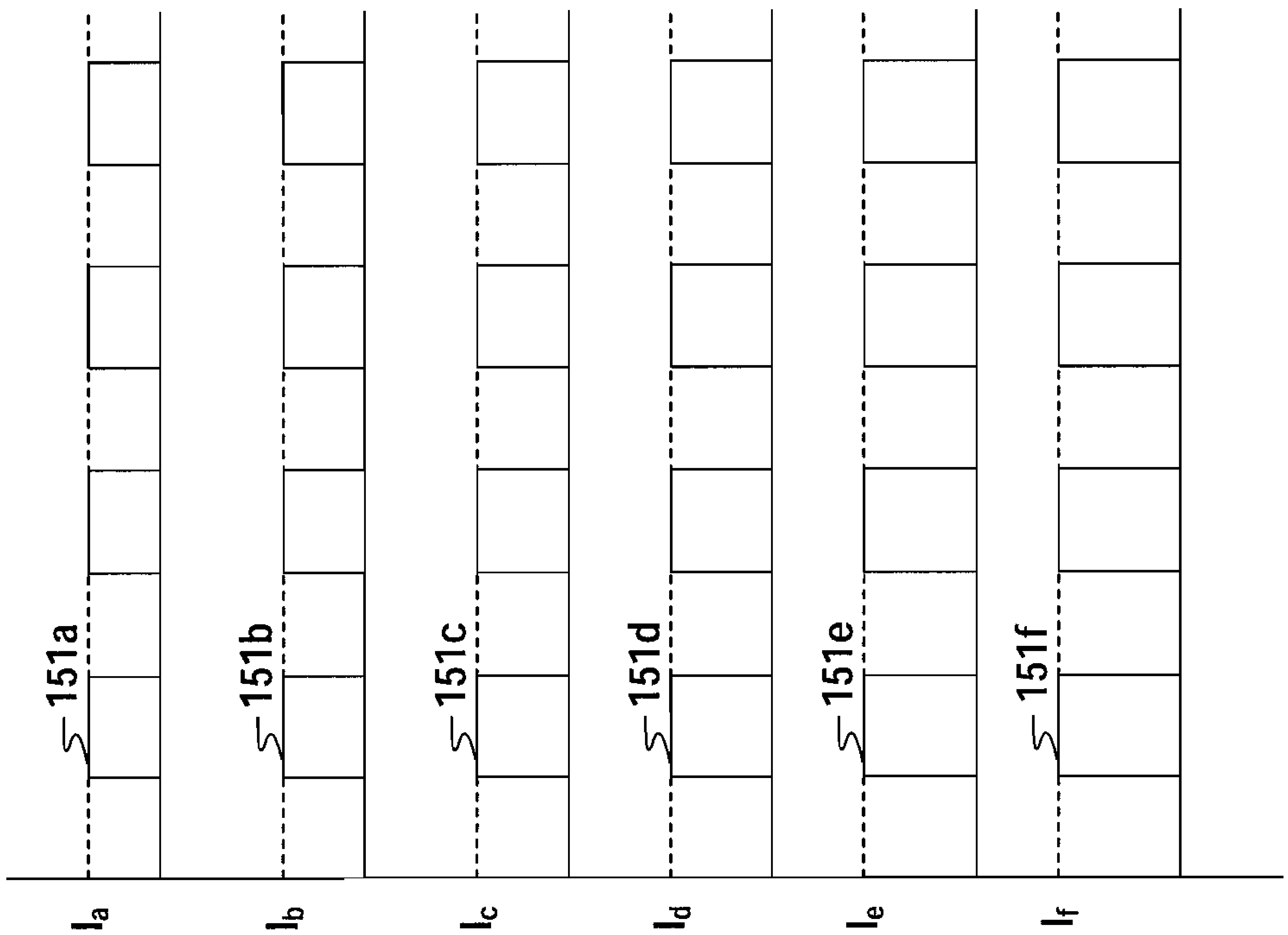

151a
151b
151c
151d
151e
151f
Ia
Ib
Ic
Id
Ie
If

FIG.3B

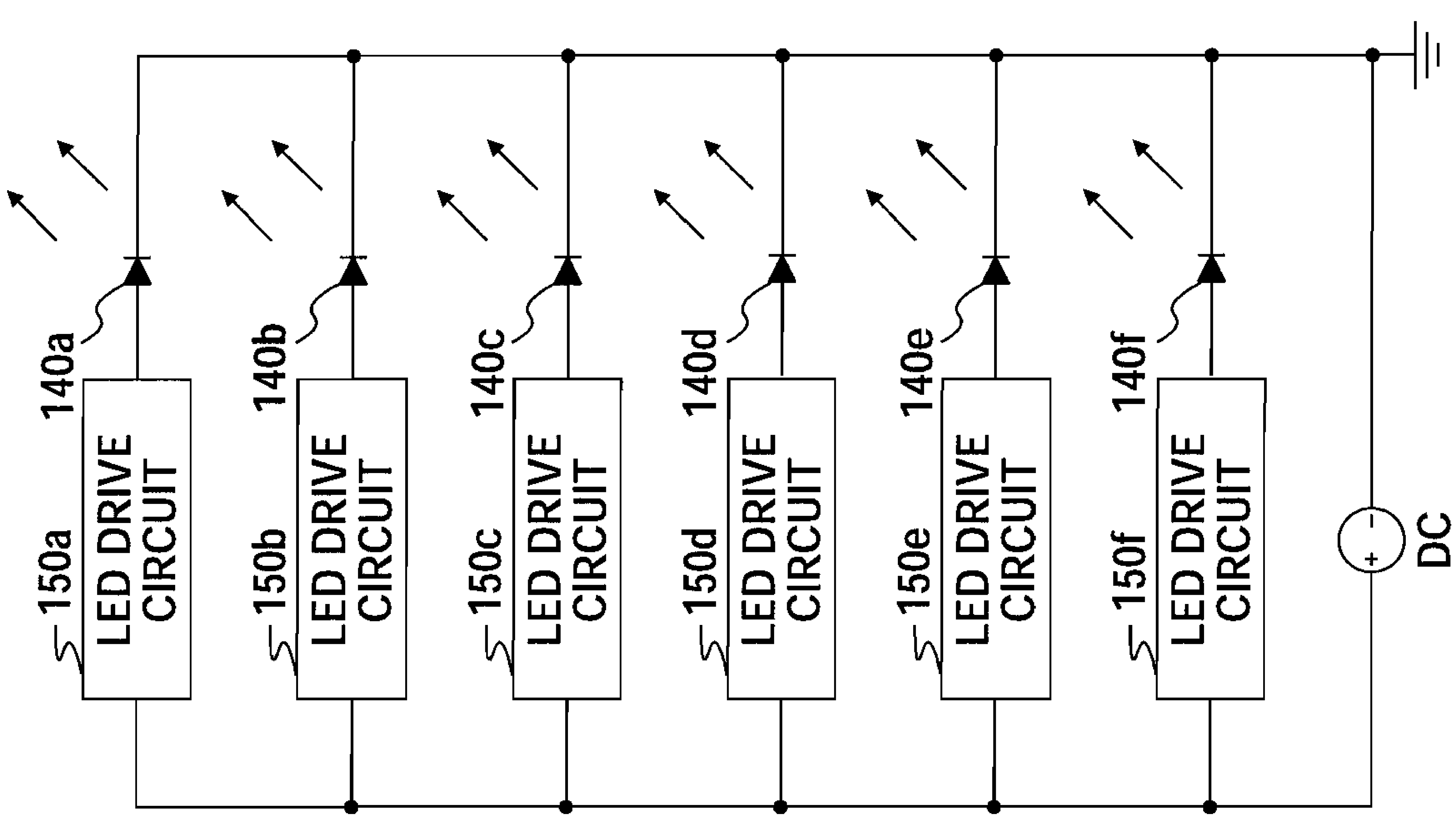

150a
LED DRIVE CIRCUIT
140a
150b
LED DRIVE CIRCUIT
140b
150c
LED DRIVE CIRCUIT
140c
150d
LED DRIVE CIRCUIT
140d
150e
LED DRIVE CIRCUIT
140e
150f
LED DRIVE CIRCUIT
140f
DC

FIG.3A

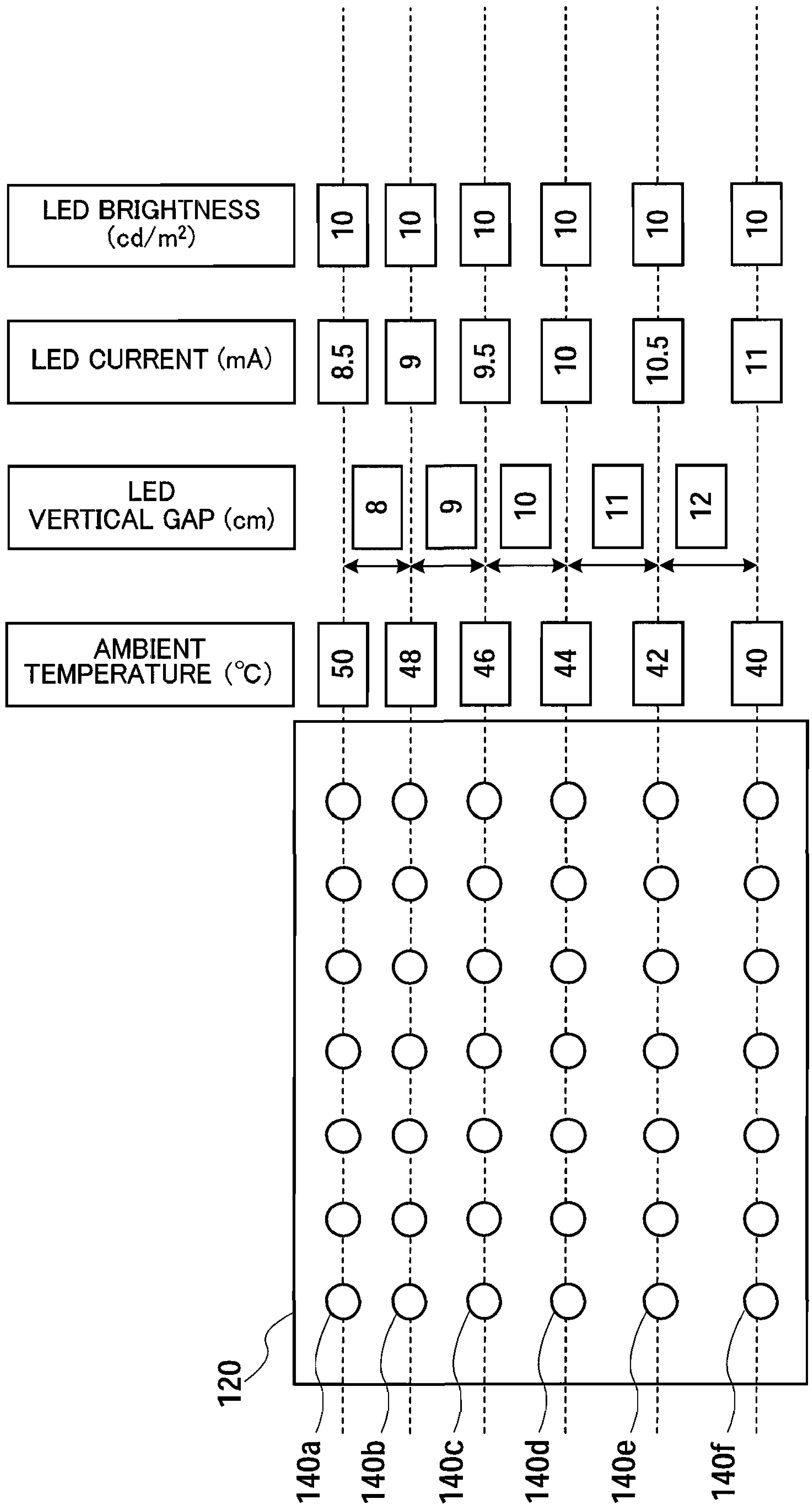

LED BRIGHTNESS (cd/m2)
10
10
10
10
10
10
LED CURRENT (mA)
8.5
9
9.5
10
10.5
11
LED VERTICAL GAP (cm)
8
9
10
11
12
AMBIENT TEMPERATURE (°C)
50
48
46
44
42
40
120
140a
140b
140c
140d
140e
140f

FIG.4

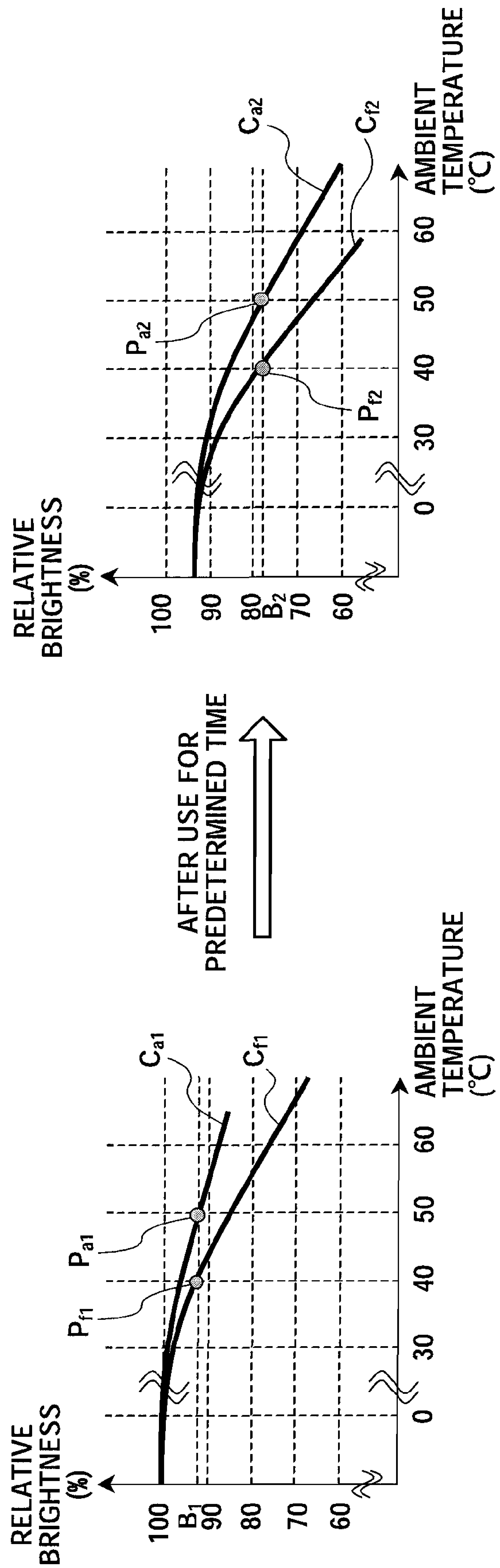

RELATIVE BRIGHTNESS (%)
100
90
80
B2
70
60
0
30
40
50
60
AMBIENT TEMPERATURE (℃)
Ca2
Cf2
Pa2
Pf2
AFTER USE FOR PREDETERMINED TIME
RELATIVE BRIGHTNESS (%)
100
B1
90
80
70
60
0
30
40
50
60
AMBIENT TEMPERATURE (℃)
Ca1
Cf1
Pa1
Pf1

FIG.5B

FIG.5A

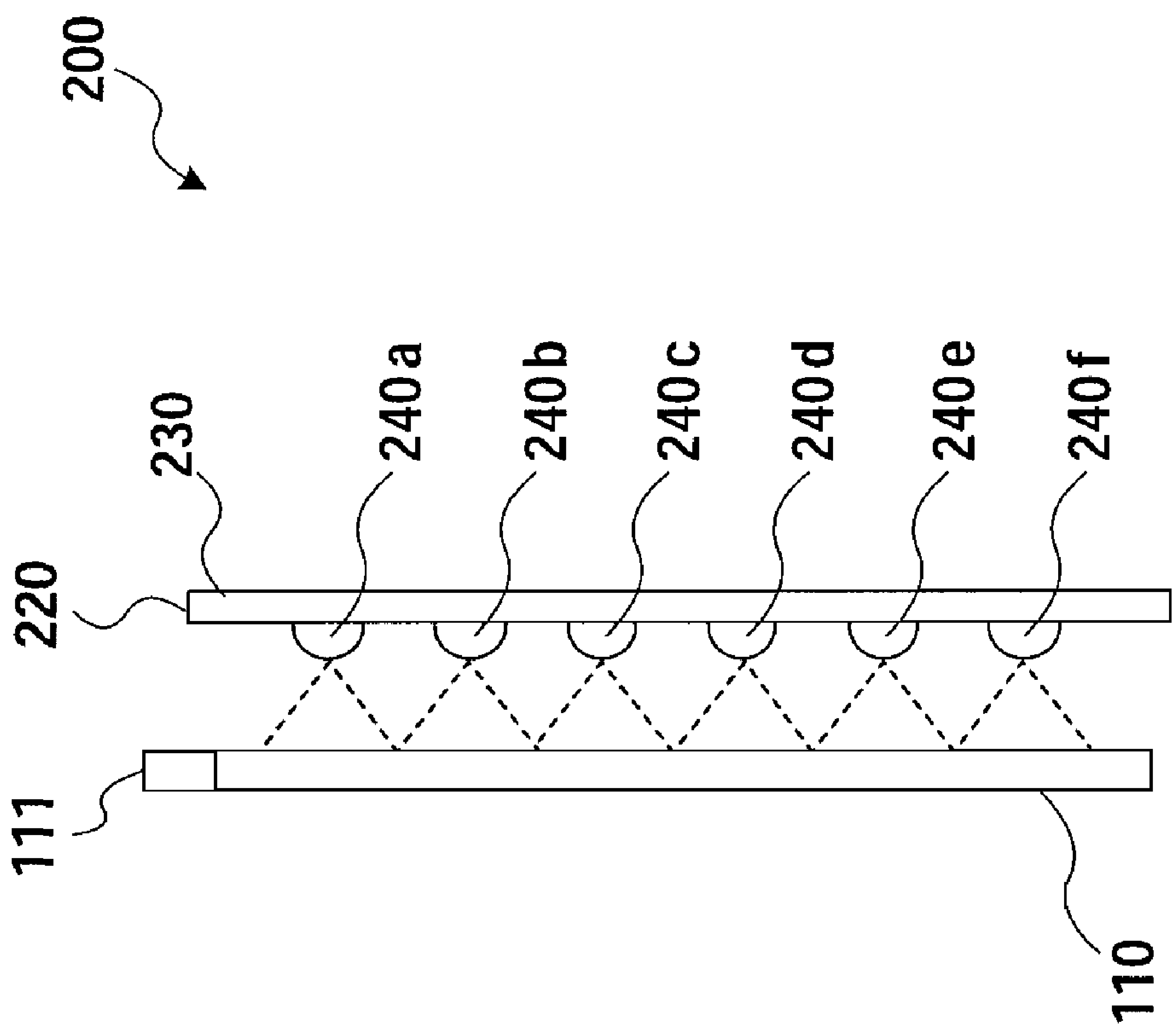


FIG.6

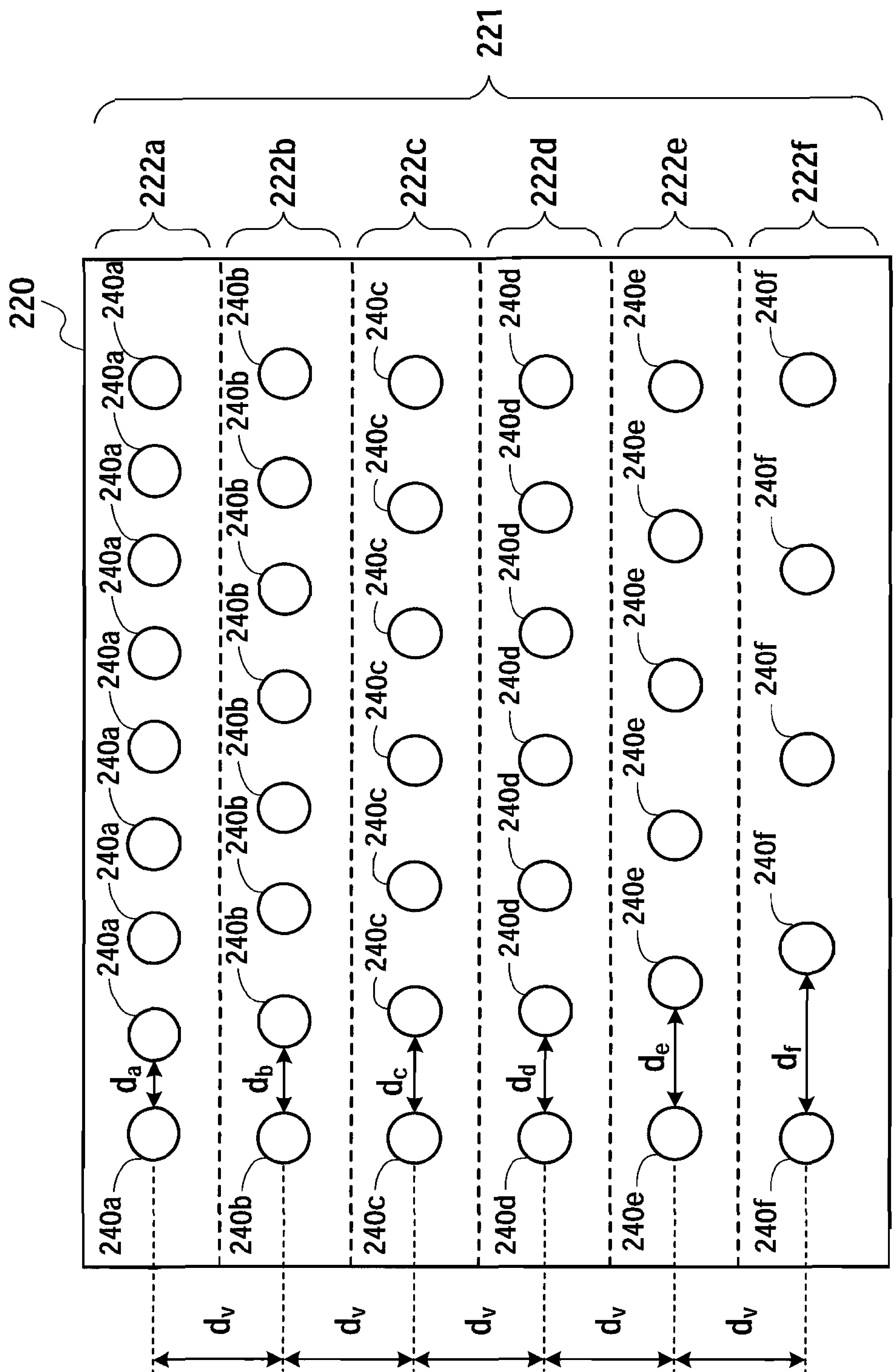
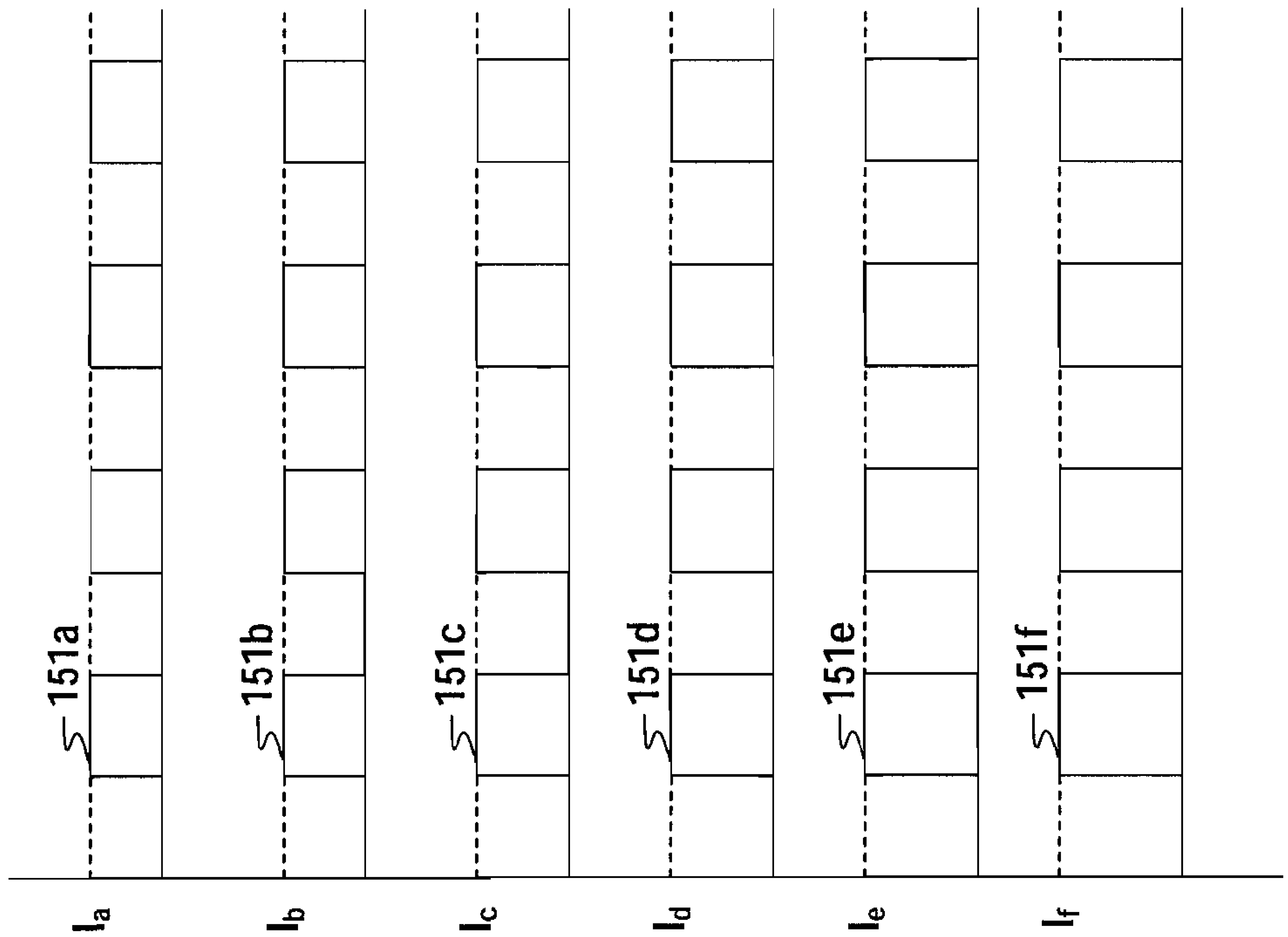
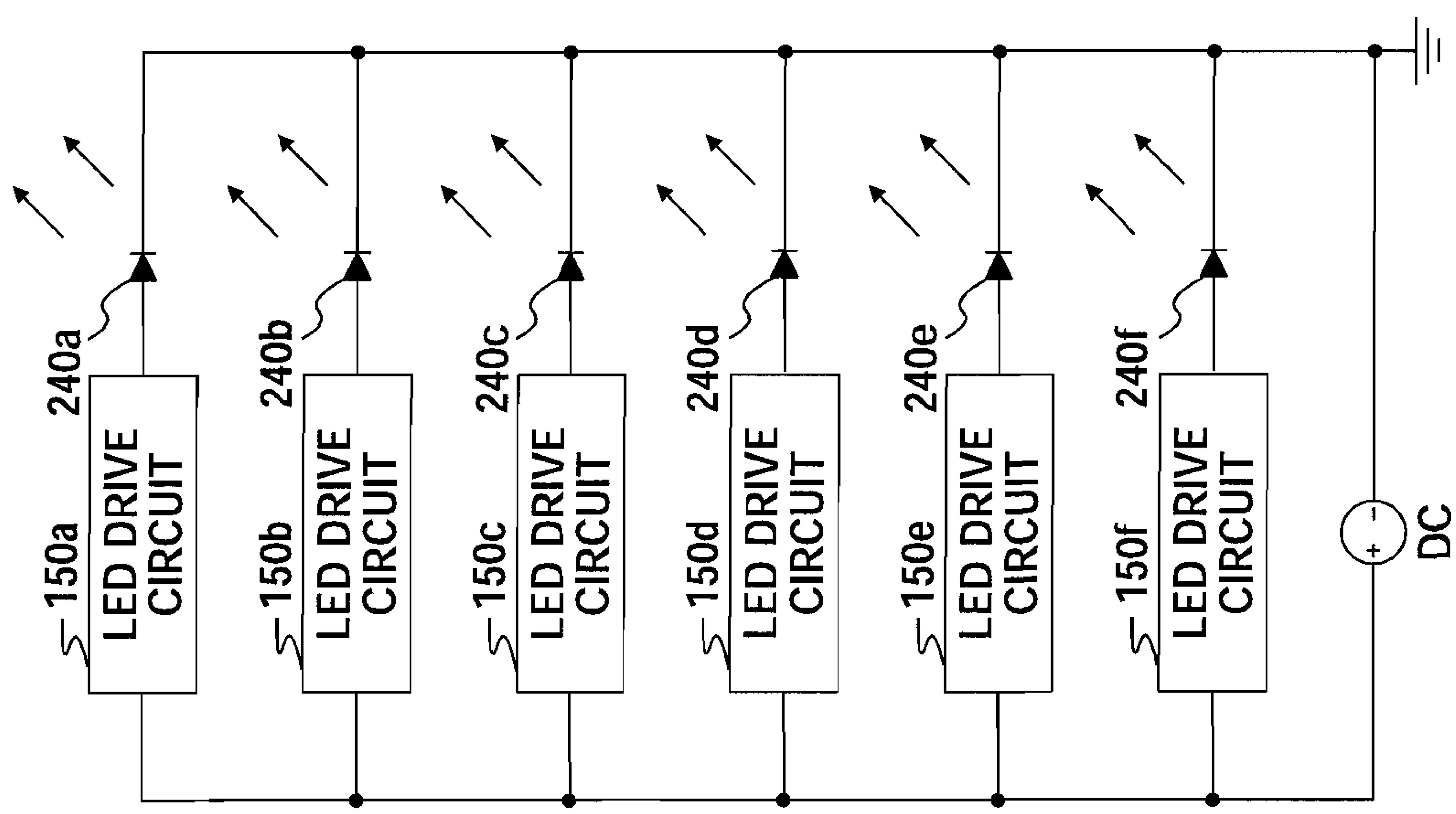

221
222a
222b
222c
222d
222e
222f
220
240a
240b
240c
240d
240e
240f
d_a
d_b
d_c
d_d
d_e
d_f
d_v

FIG.7



151a
151b
151c
151d
151e
151f
I_a
I_b
I_c
I_d
I_e
I_f

FIG.8B



150a
LED DRIVE CIRCUIT
240a
150b
LED DRIVE CIRCUIT
240b
150c
LED DRIVE CIRCUIT
240c
150d
LED DRIVE CIRCUIT
240d
150e
LED DRIVE CIRCUIT
240e
150f
LED DRIVE CIRCUIT
240f
DC

FIG.8A

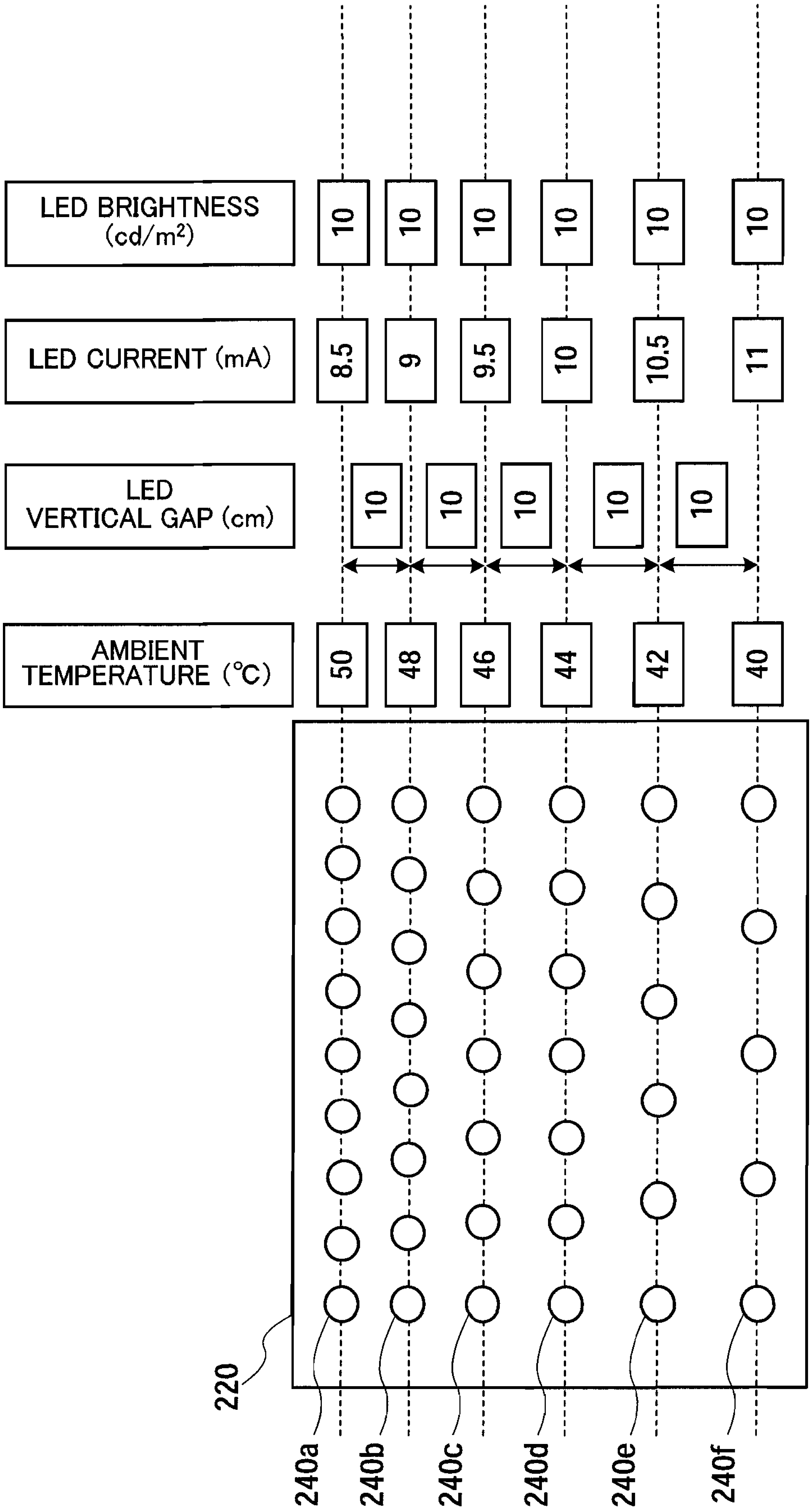

LED BRIGHTNESS (cd/m²)
10
10
10
10
10
10
LED CURRENT (mA)
8.5
9
9.5
10
10.5
11
LED VERTICAL GAP (cm)
10
10
10
10
10
AMBIENT TEMPERATURE (℃)
50
48
46
44
42
40
220
240a
240b
240c
240d
240e
240f

FIG.9

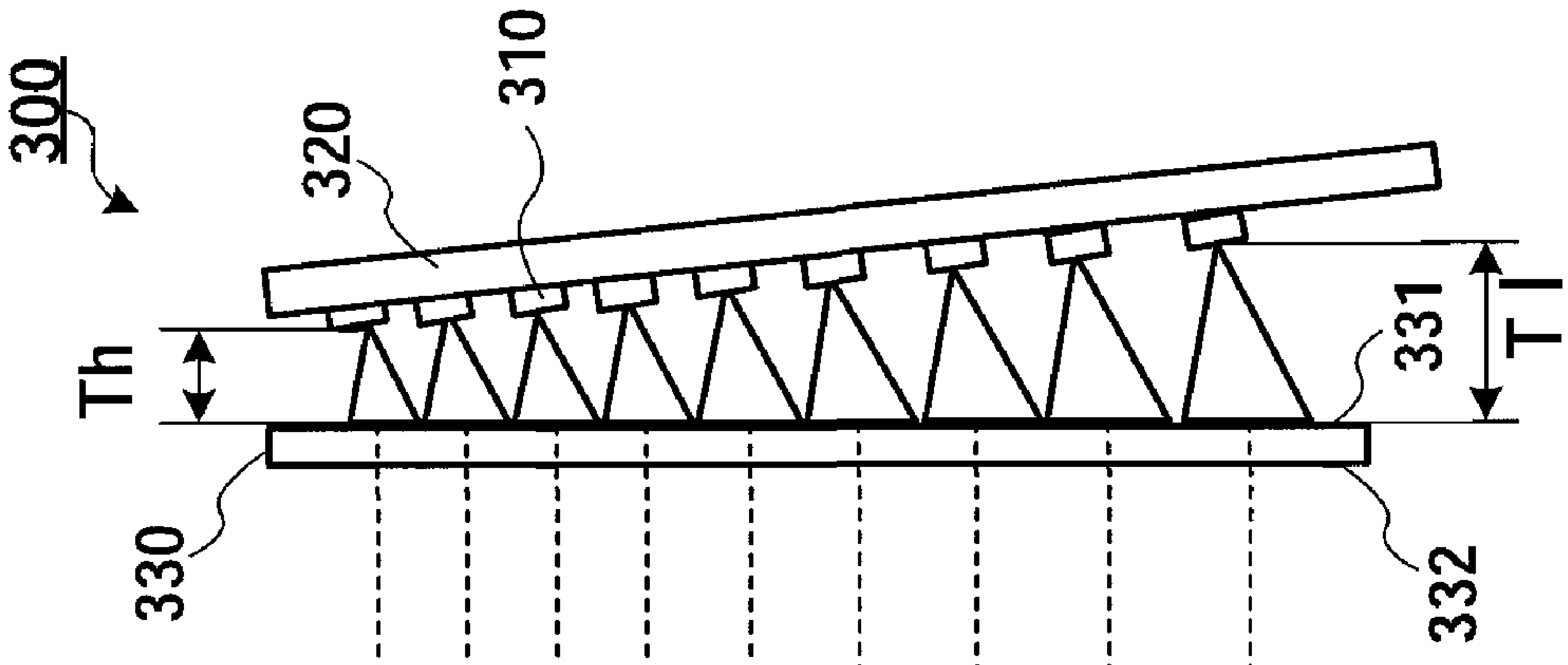


FIG.10B

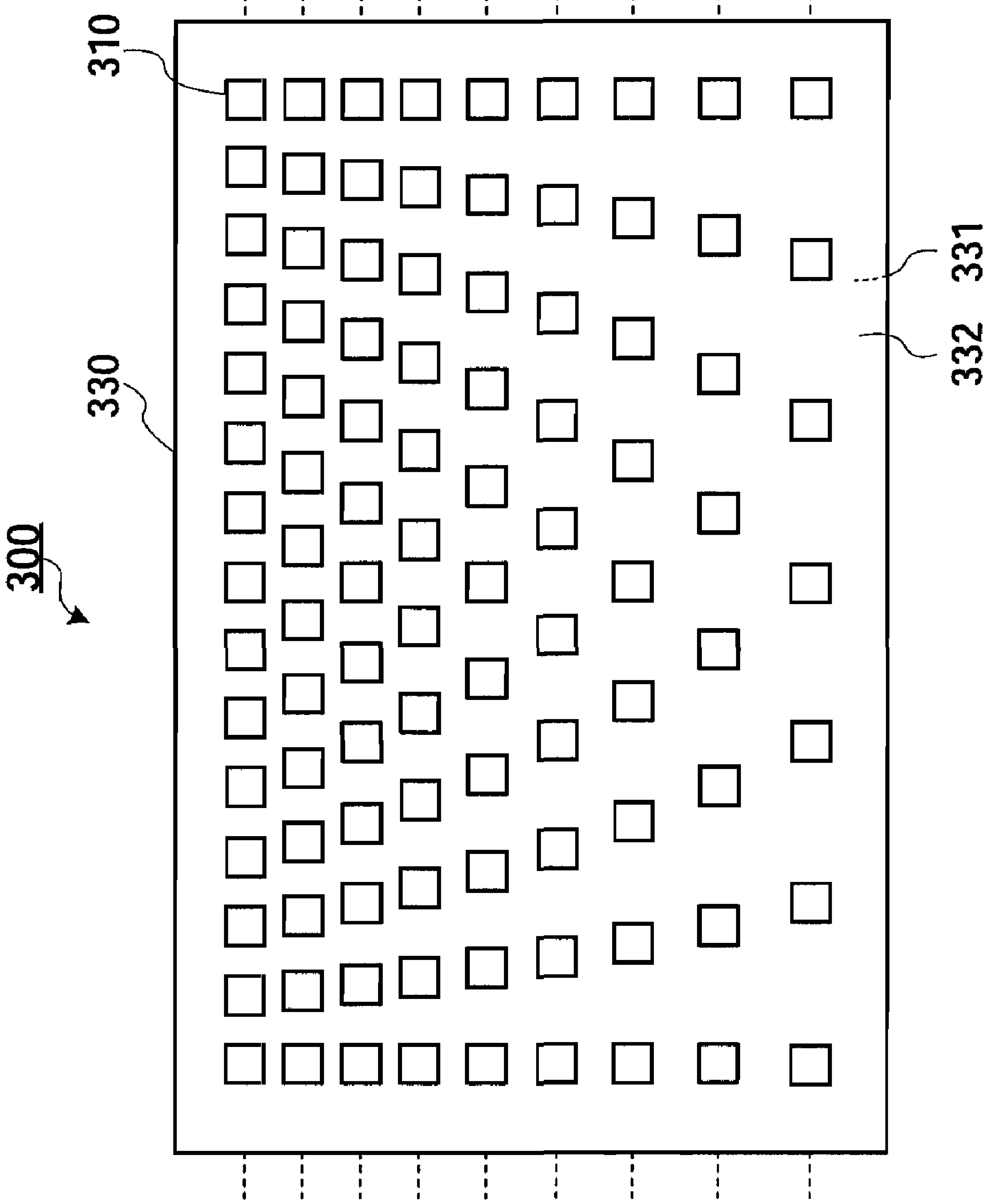


FIG.10A

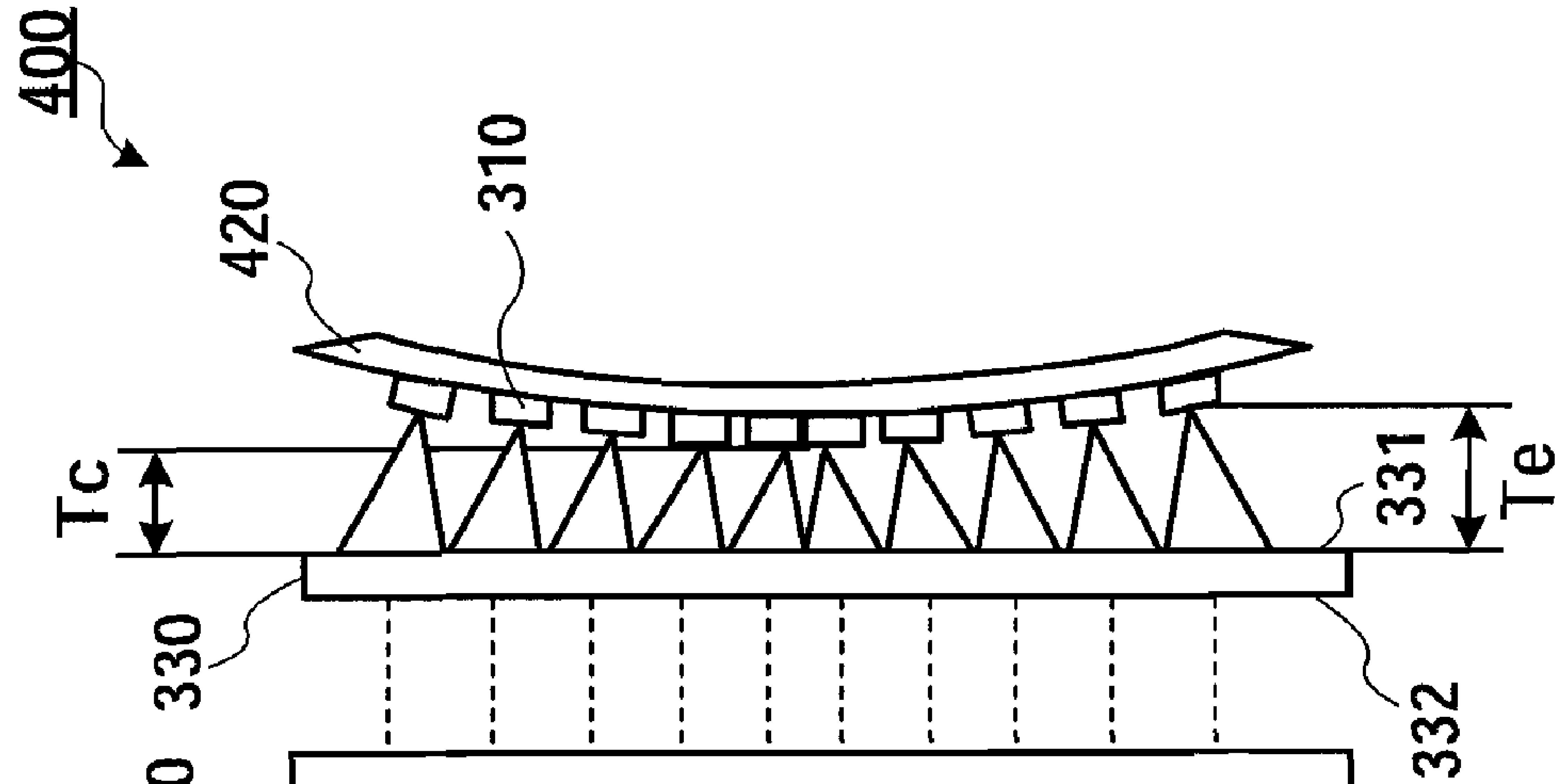


FIG.11B

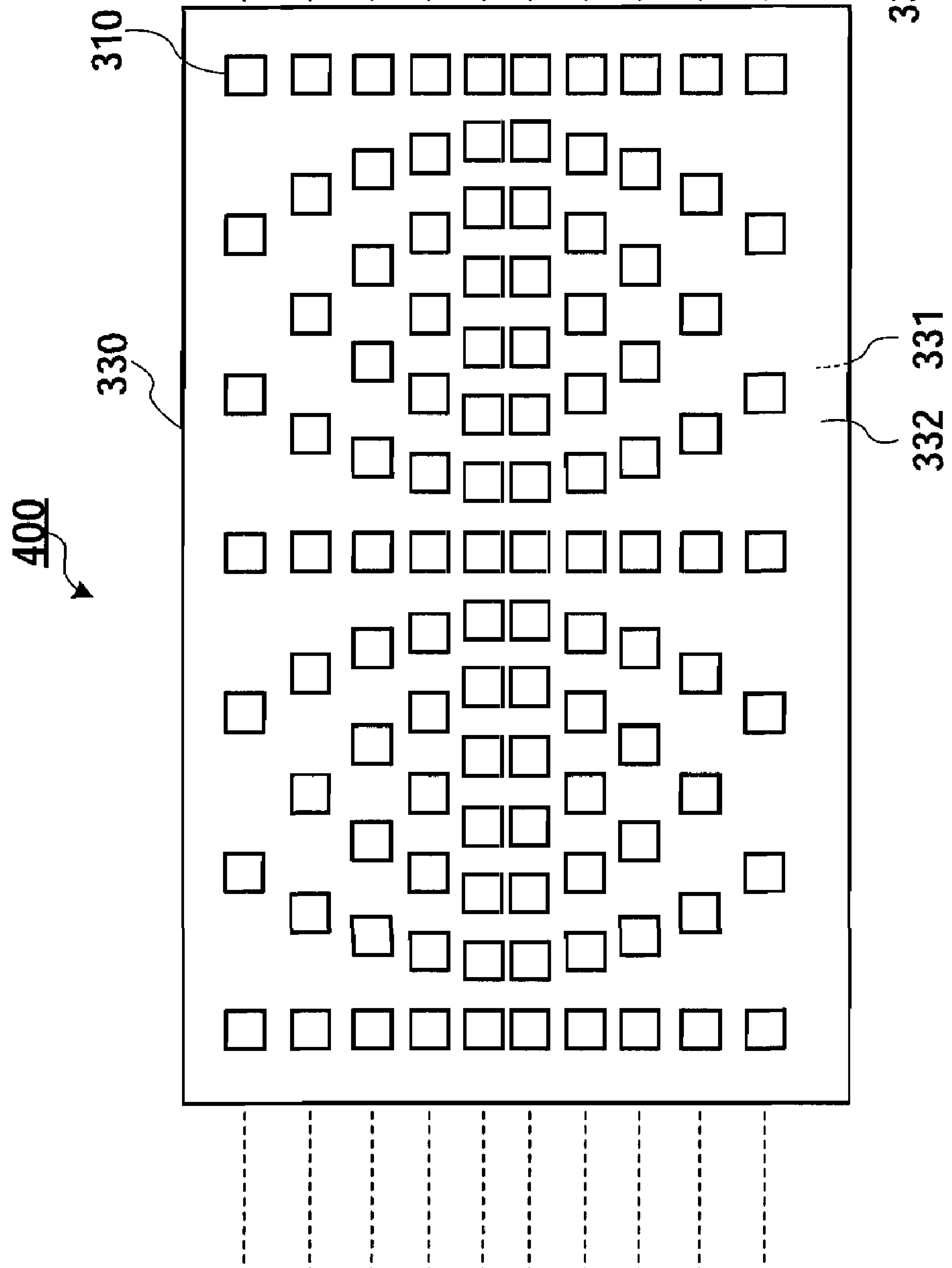


FIG.11A

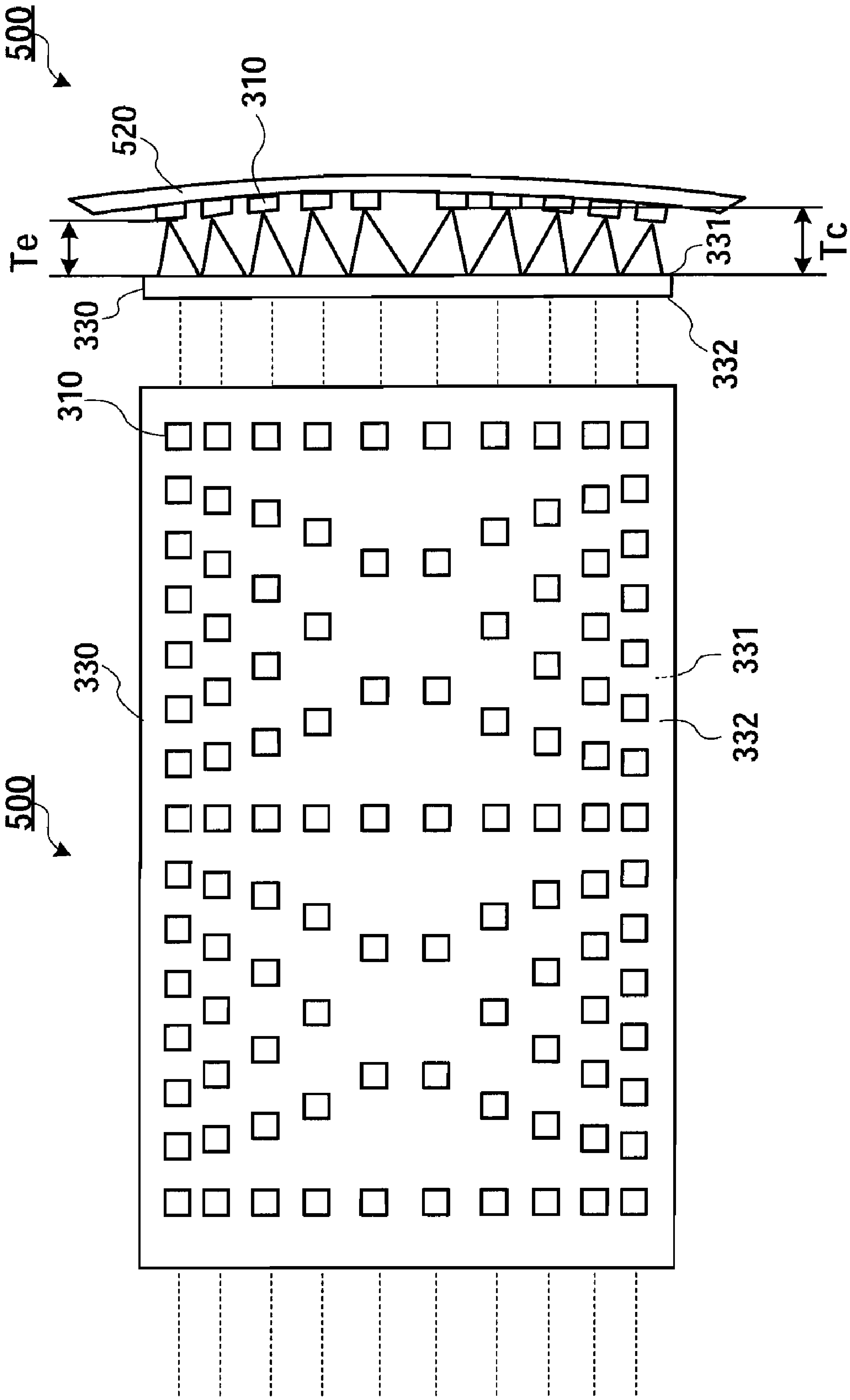


FIG.12B

FIG.12A

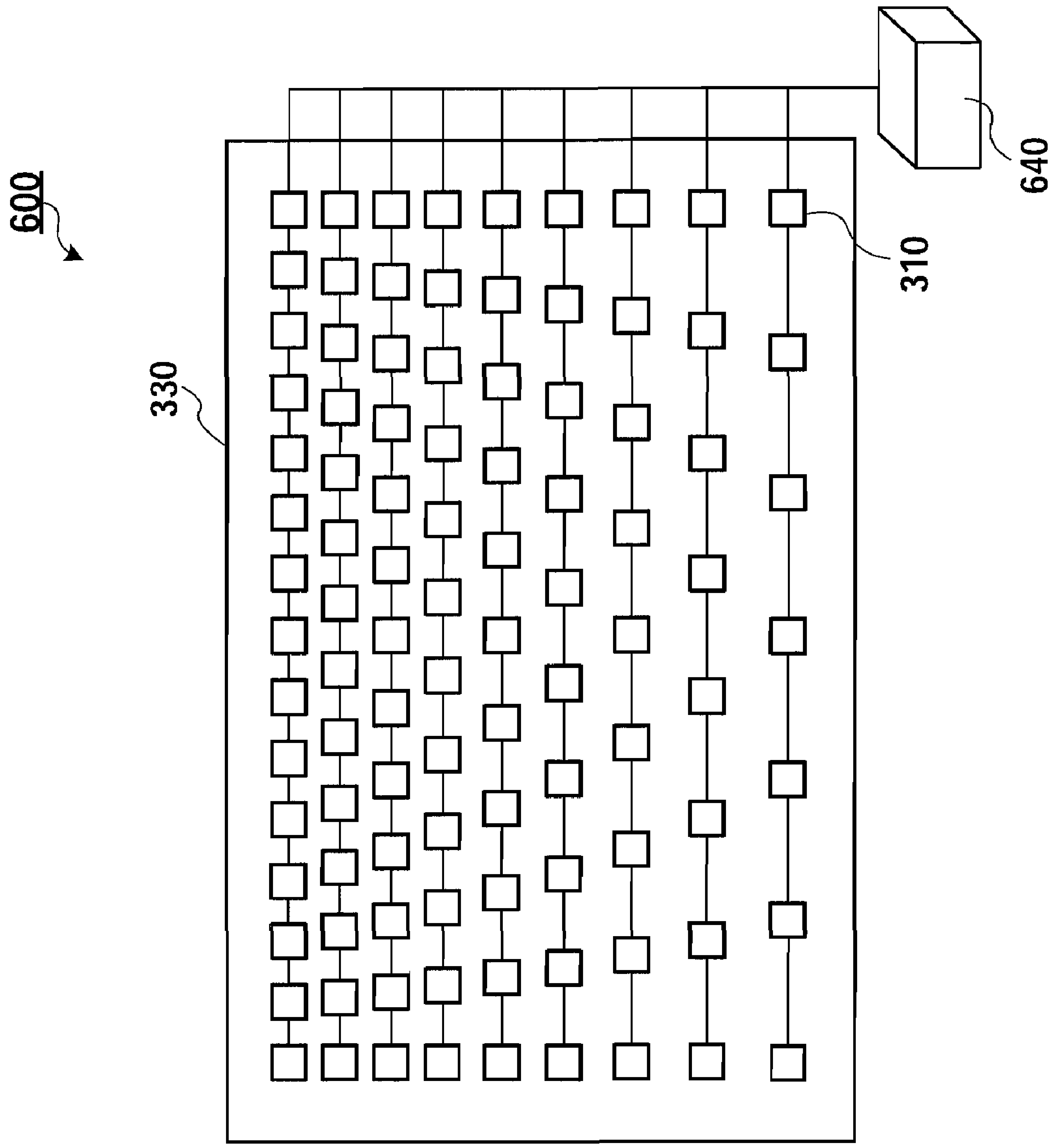


FIG.13

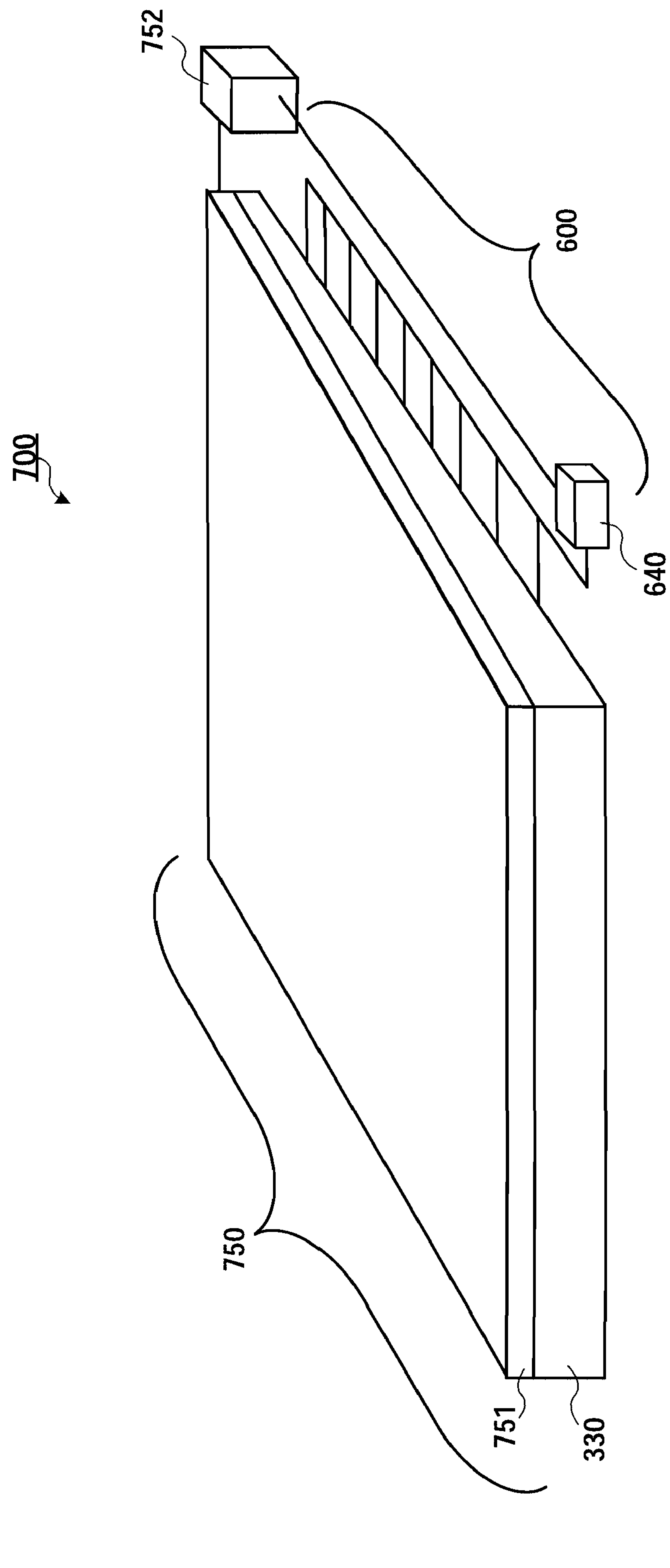


FIG.14

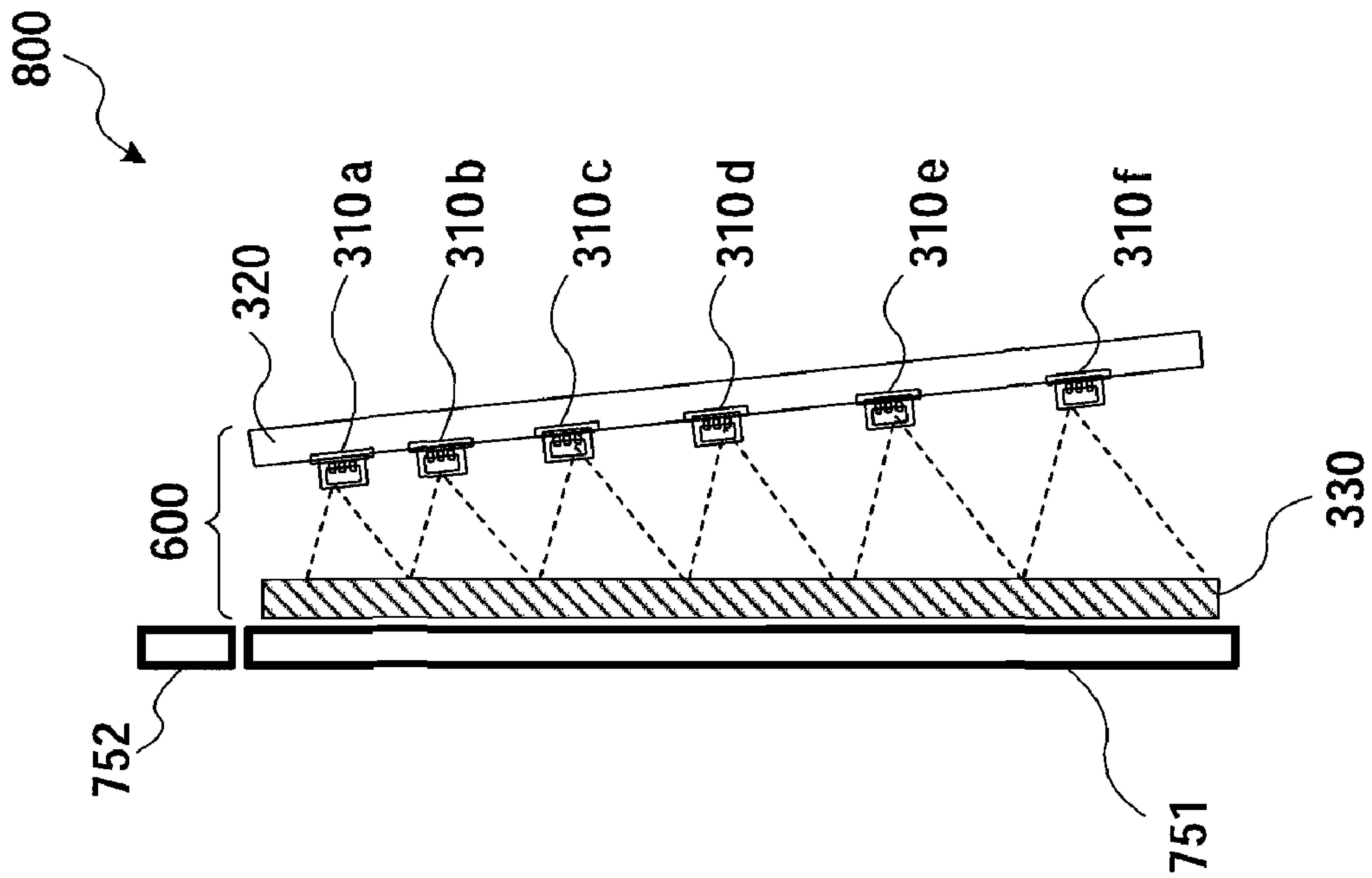


FIG.15

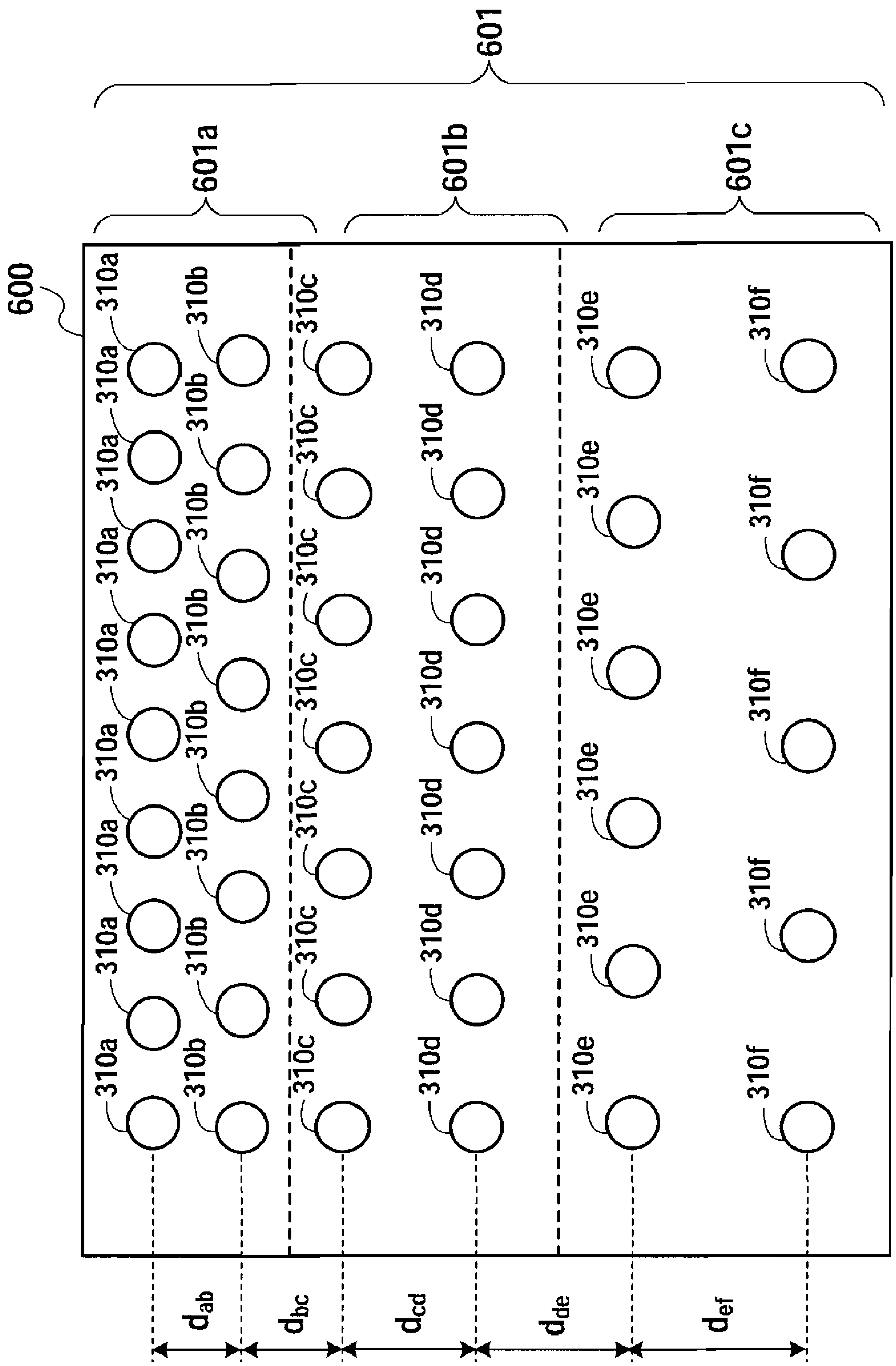

601
601a
601b
601c
600
310a
310b
310c
310d
310e
310f
dab
dbc
dcd
dde
def

FIG.16

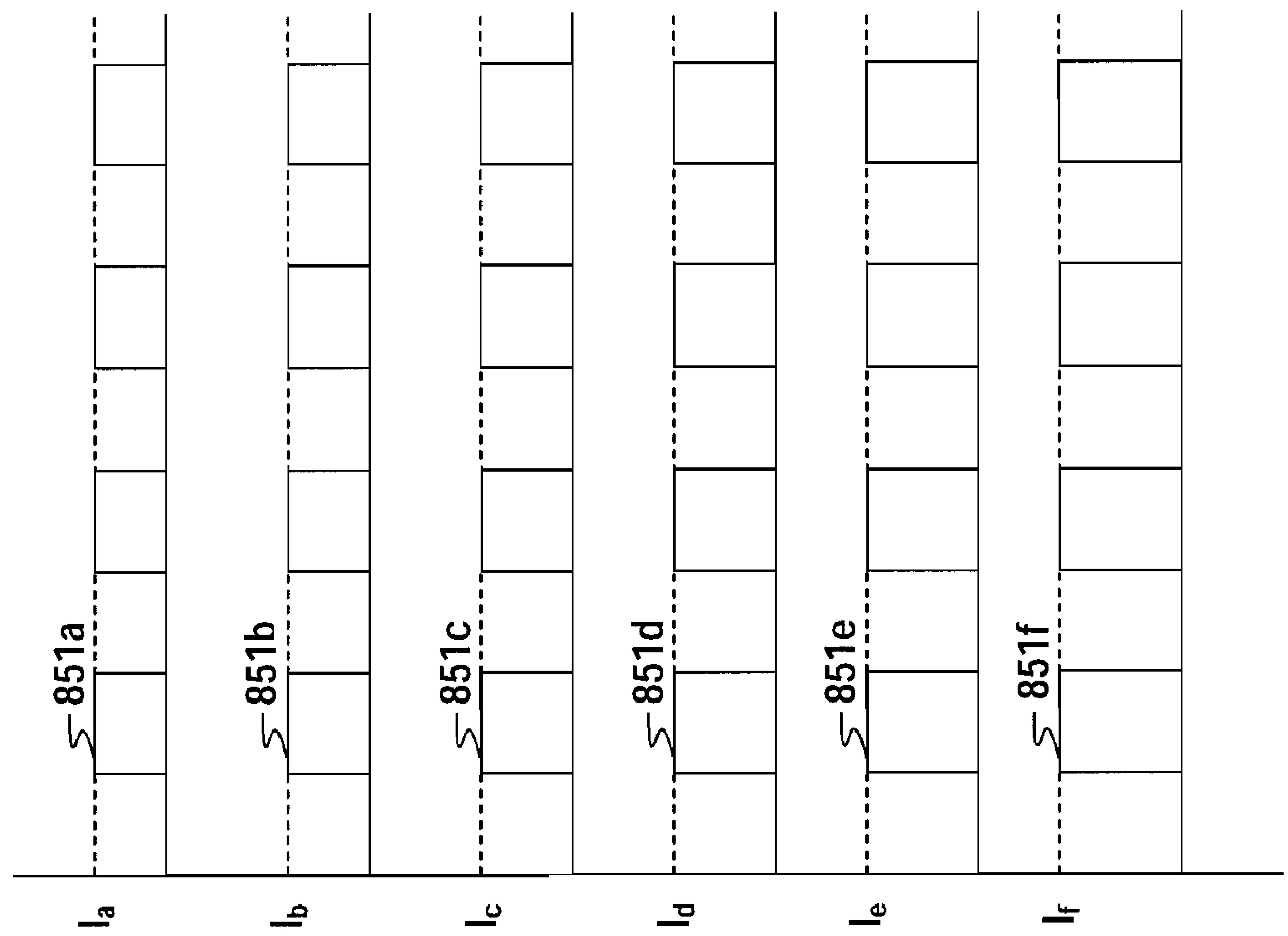


FIG.17B

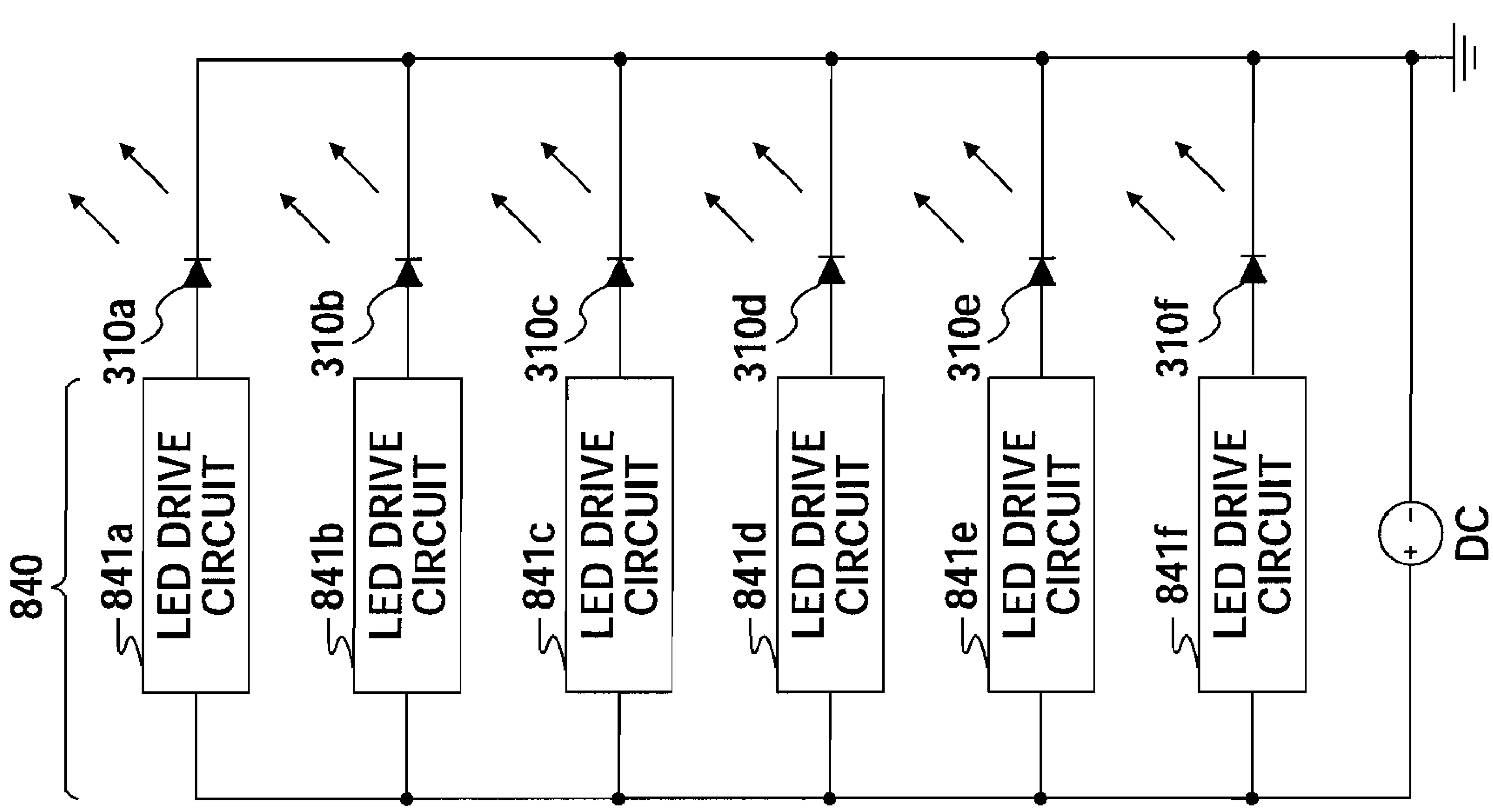
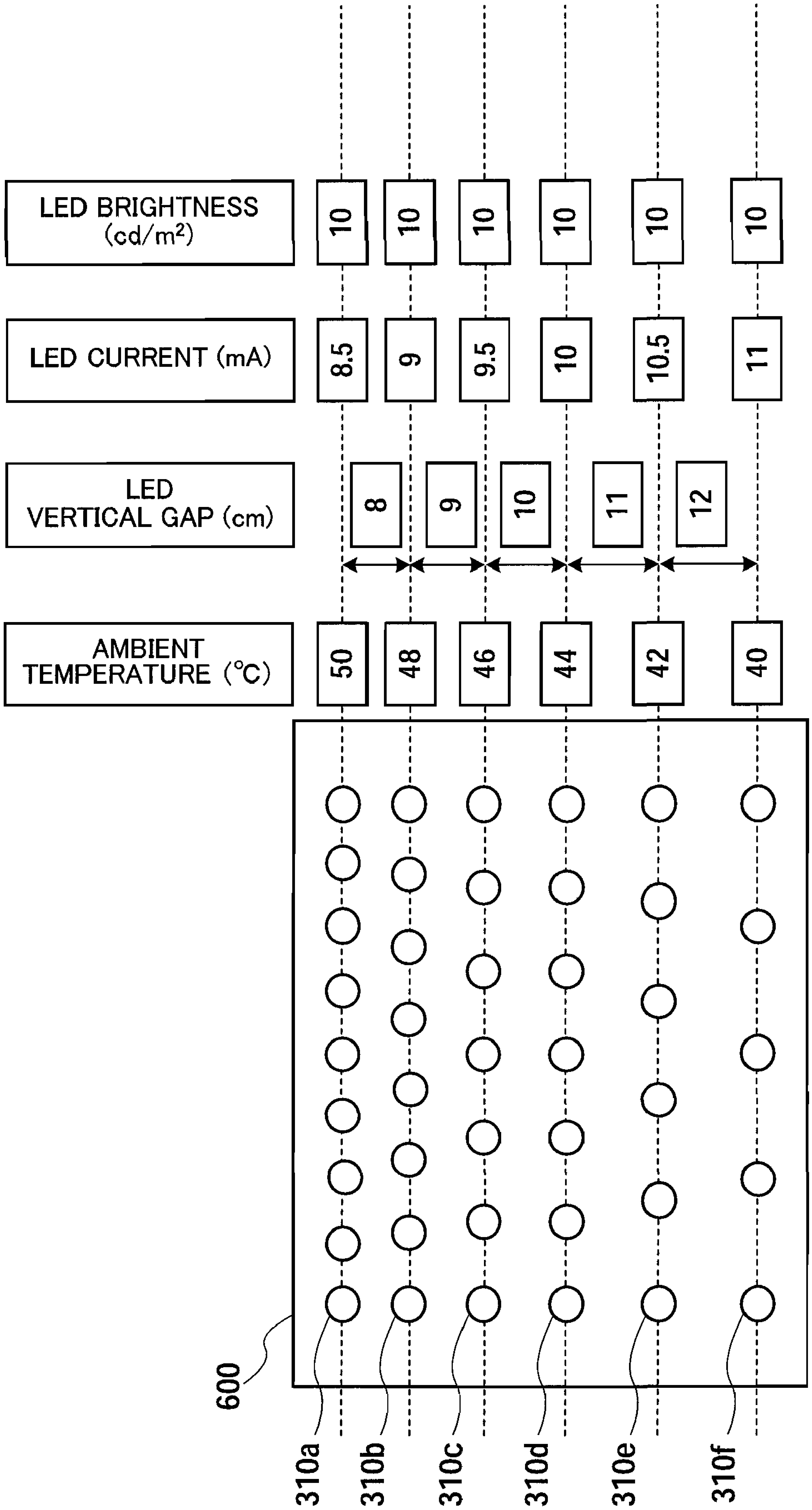


FIG.17A



LED BRIGHTNESS (cd/m2)
10
10
10
10
10
10
LED CURRENT (mA)
8.5
9
9.5
10
10.5
11
LED VERTICAL GAP (cm)
8
9
10
11
12
AMBIENT TEMPERATURE (℃)
50
48
46
44
42
40
600
310a
310b
310c
310d
310e
310f

FIG.18

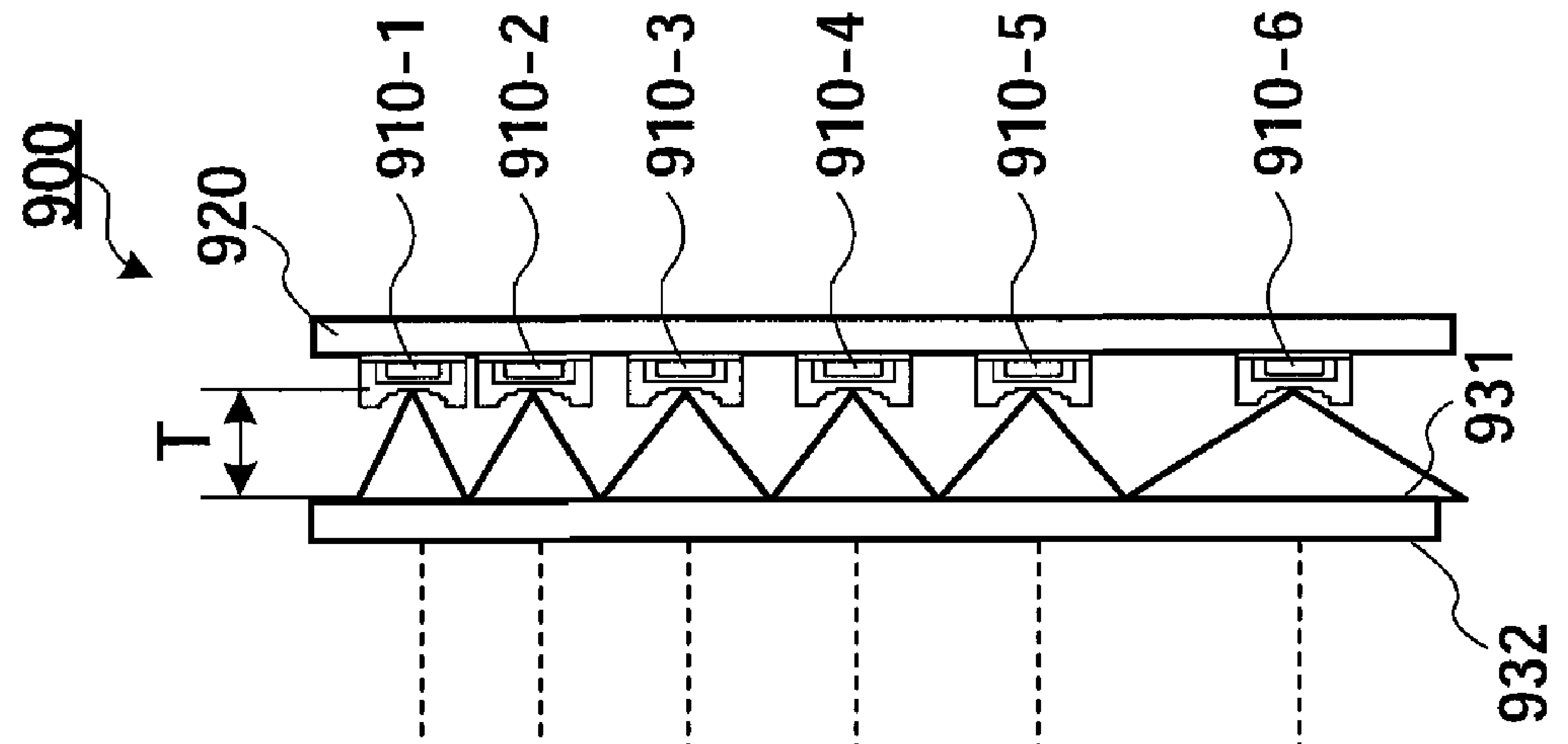


FIG.19B

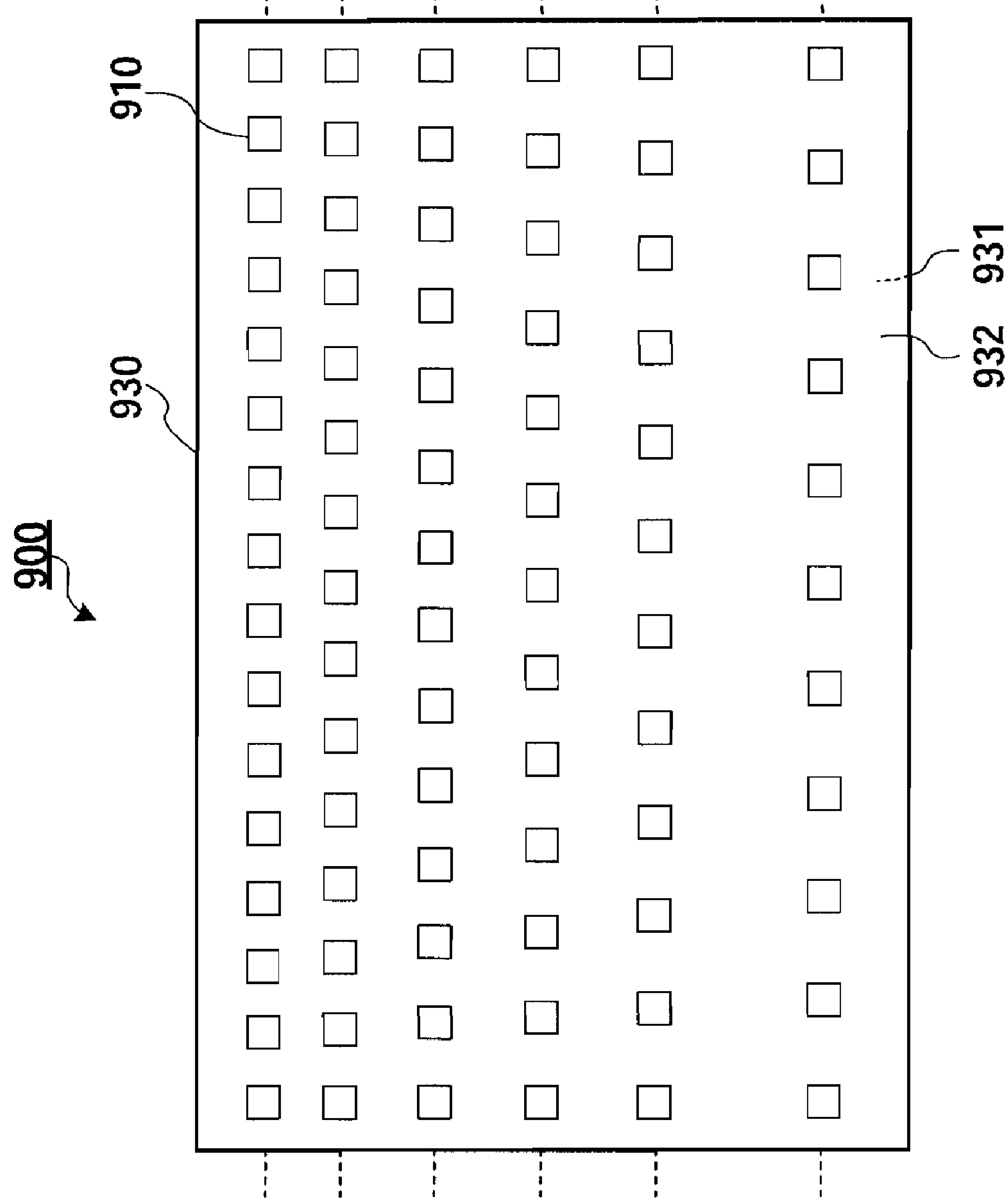


FIG.19A

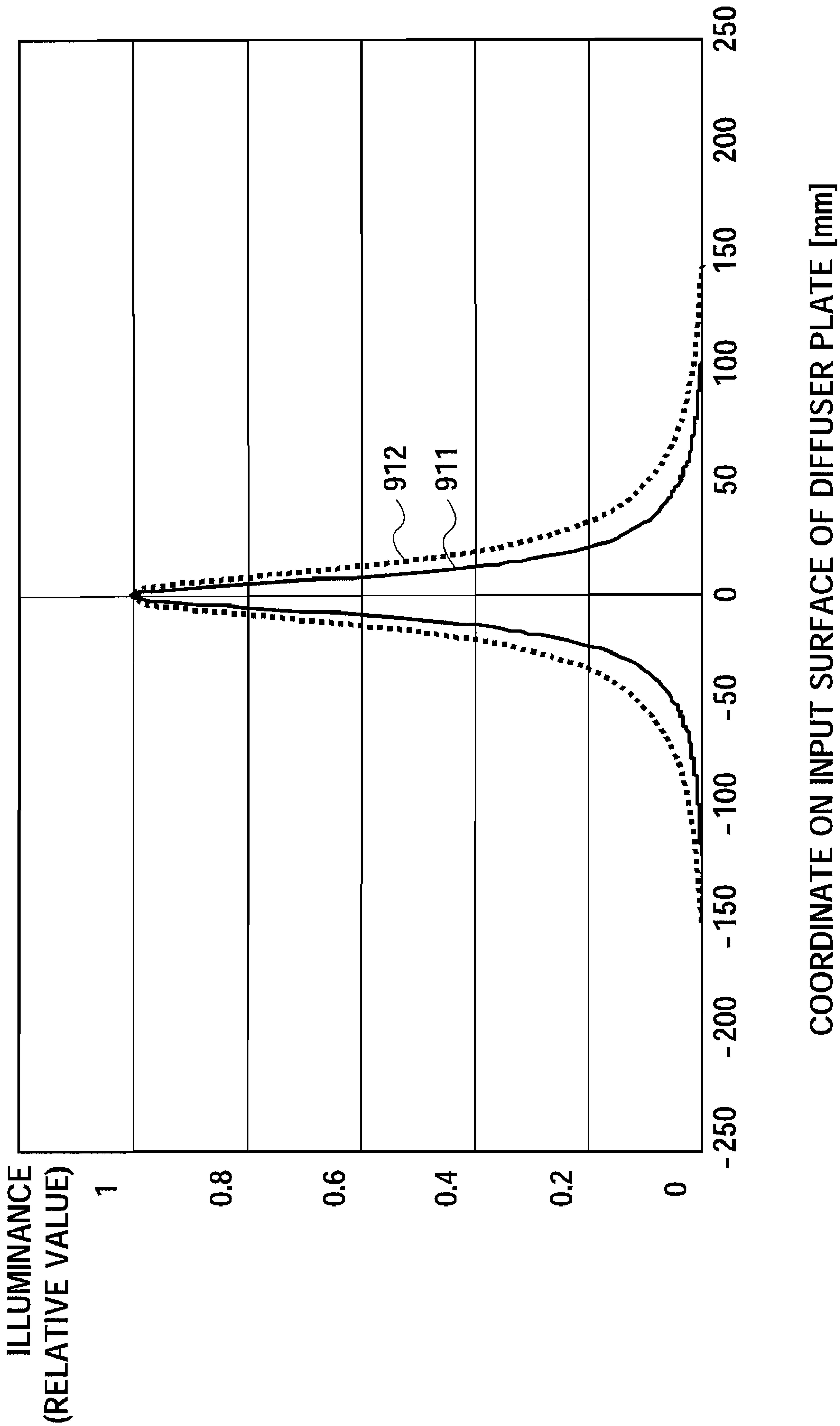

ILLUMINANCE (RELATIVE VALUE)
1
0.8
0.6
0.4
0.2
0
-250
-200
-150
-100
-50
0
50
100
150
200
250
912
911
COORDINATE ON INPUT SURFACE OF DIFFUSER PLATE [mm]

FIG.20

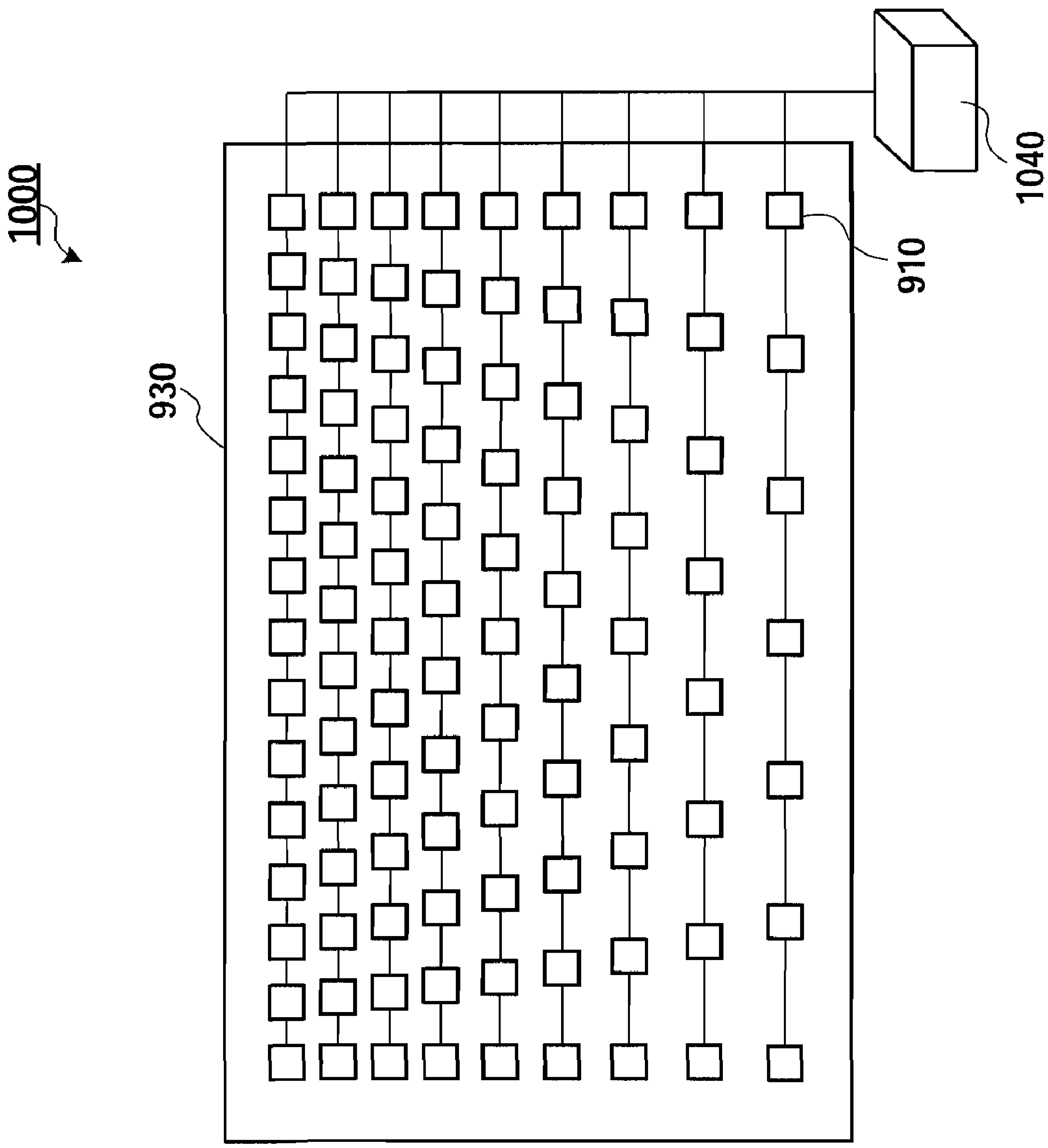


FIG.21

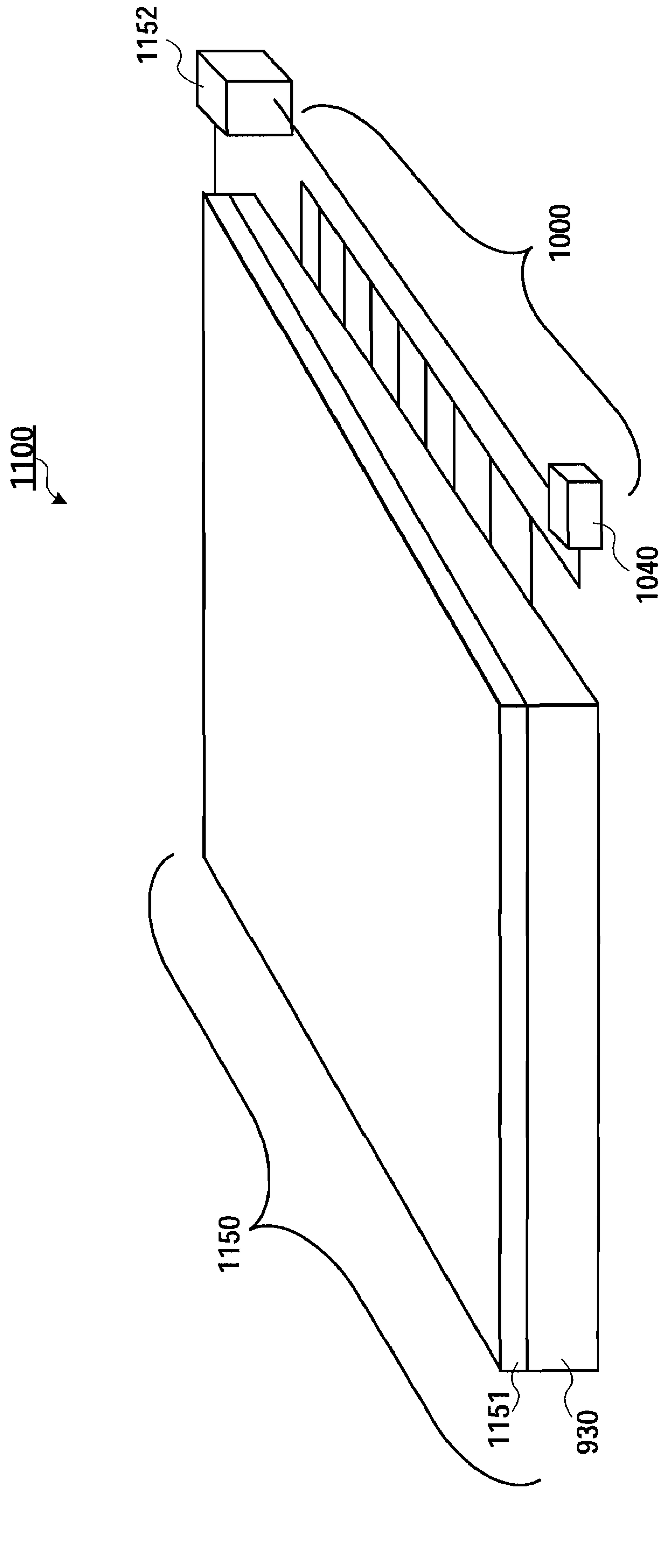


FIG.22

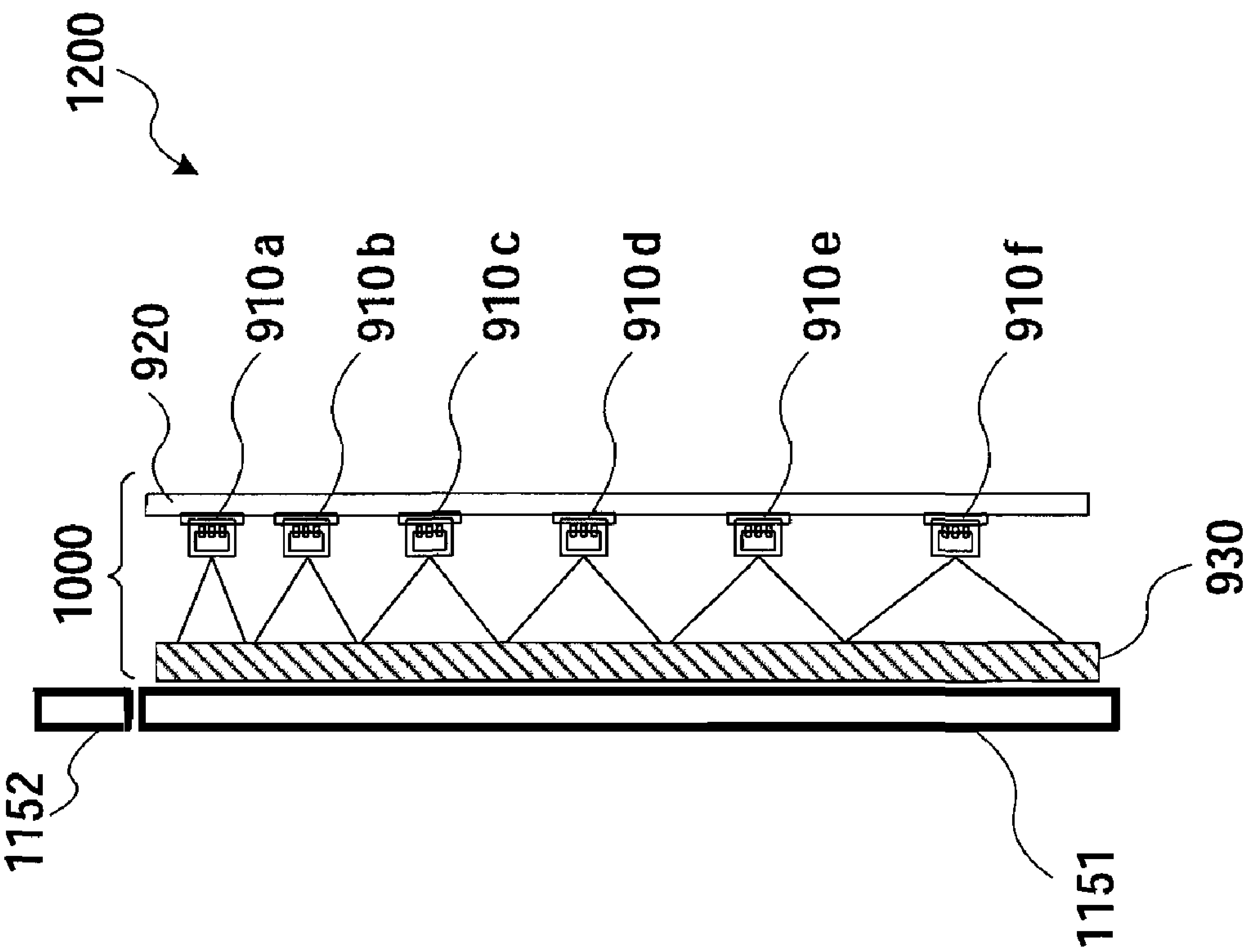


FIG.23

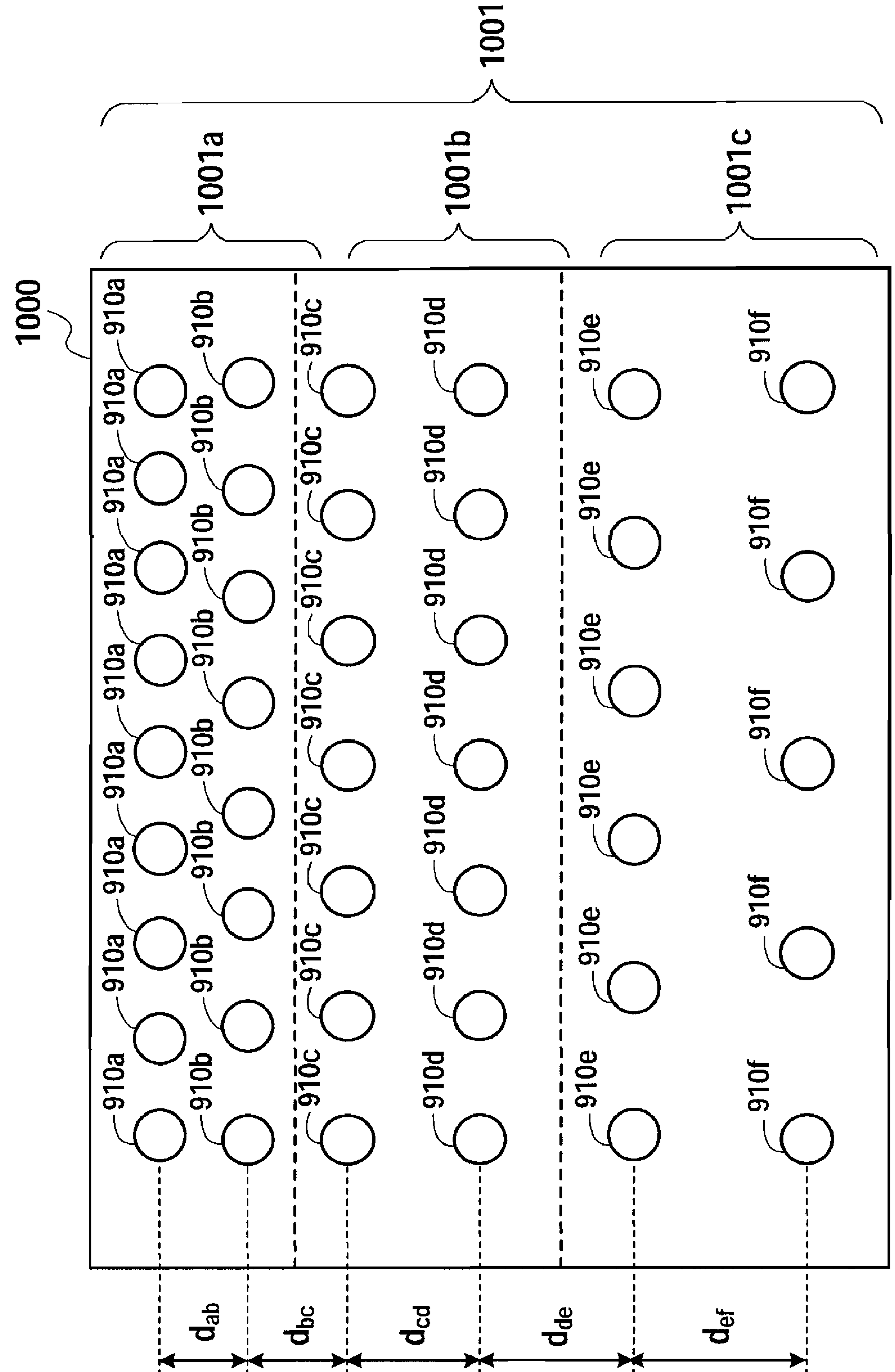

1001
1001a
1001b
1001c
1000
910a
910b
910c
910d
910e
910f
d_{ab}
d_{bc}
d_{cd}
d_{de}
d_{ef}

FIG.24

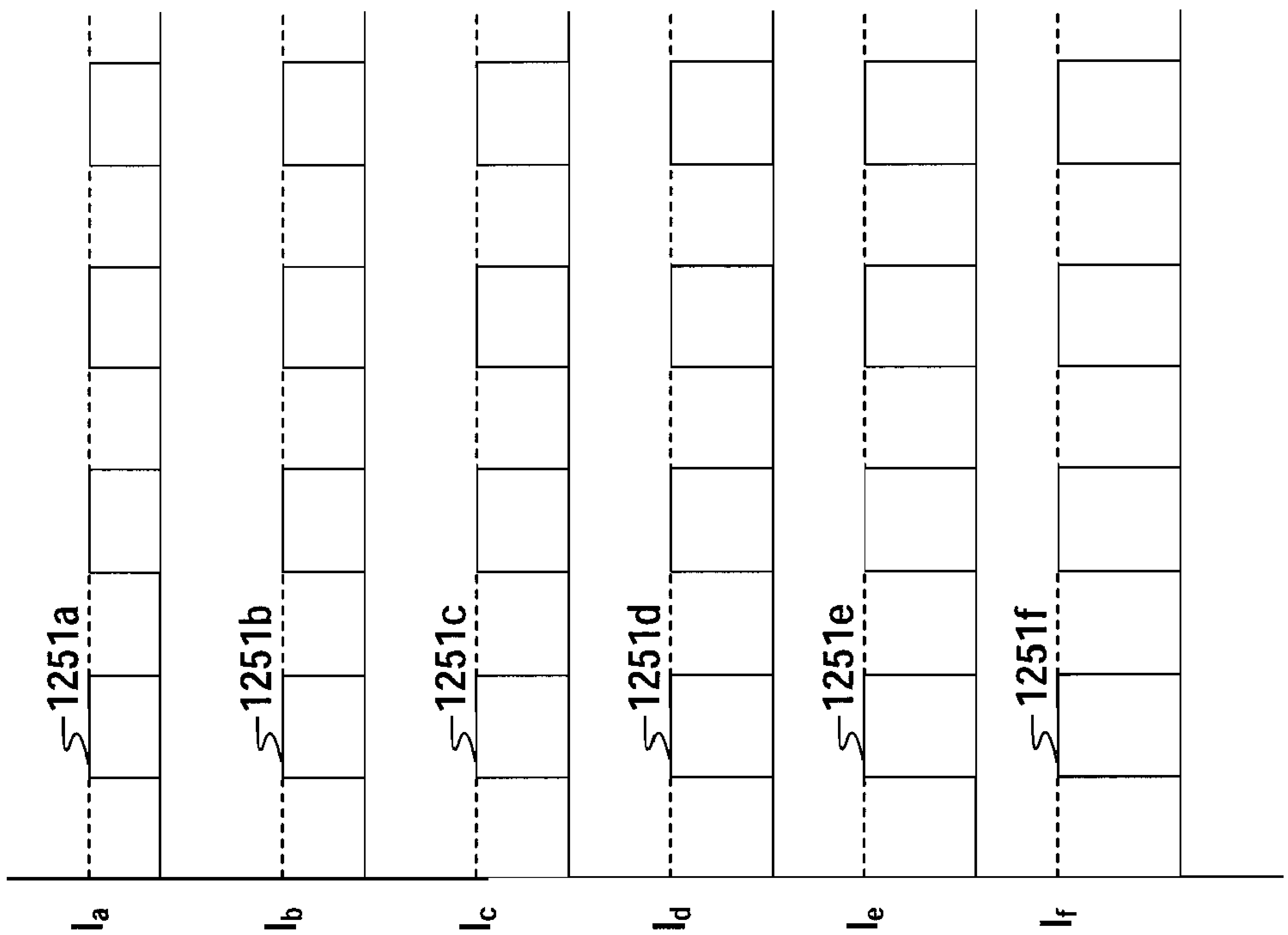


FIG.25B

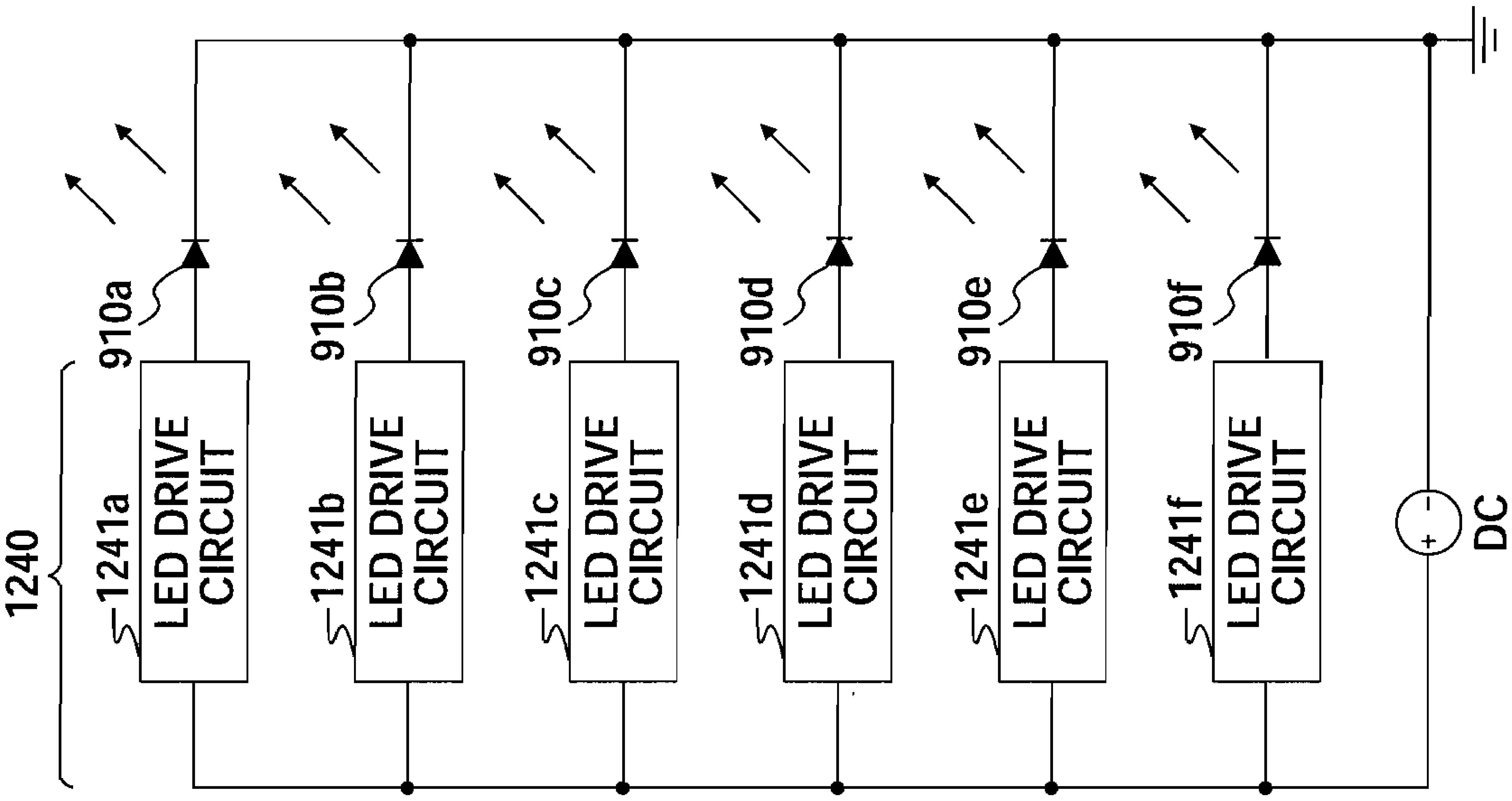
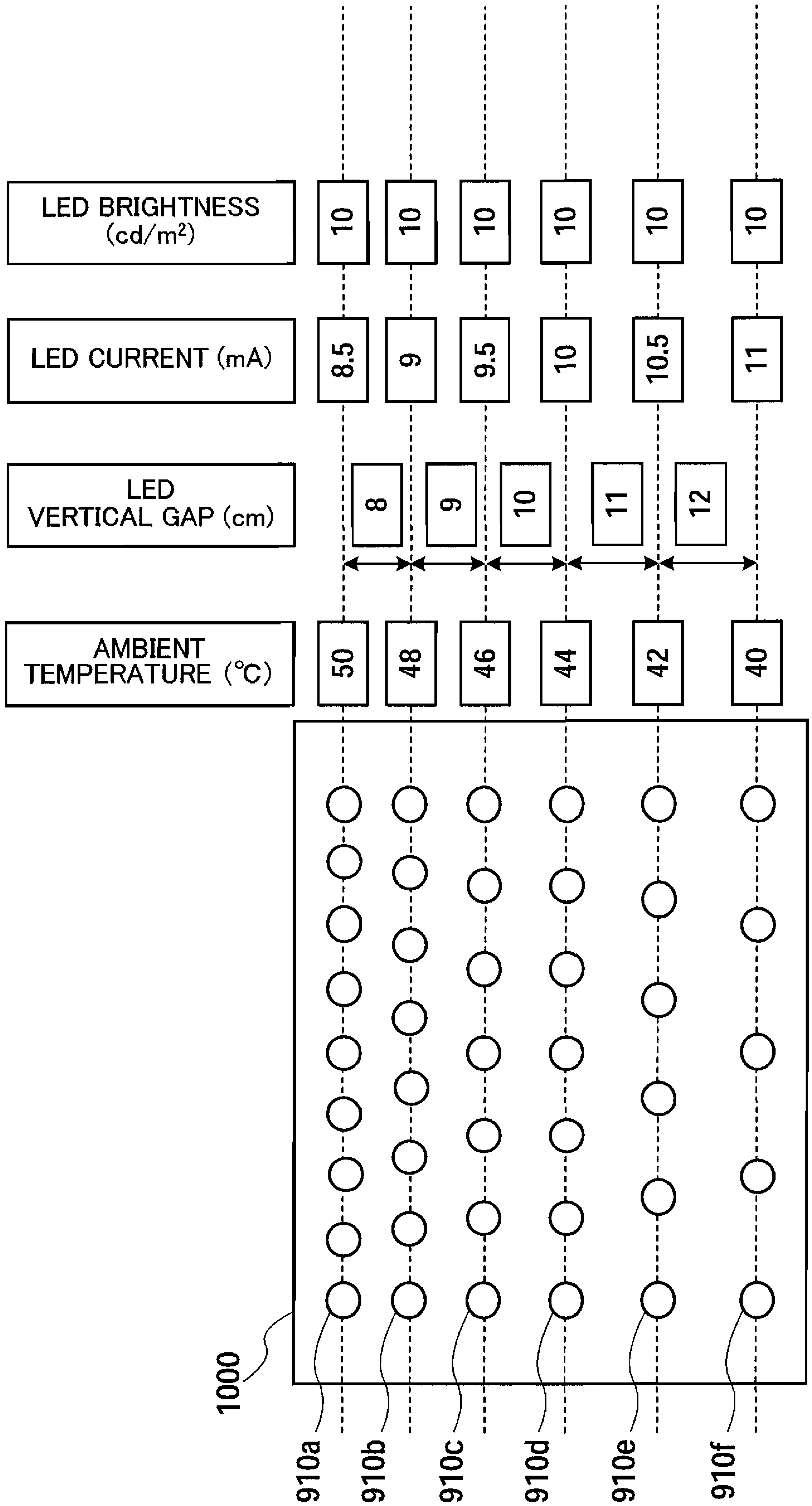


FIG.25A



LED BRIGHTNESS (cd/m2)
10
10
10
10
10
10
LED CURRENT (mA)
8.5
9
9.5
10
10.5
11
LED VERTICAL GAP (cm)
8
9
10
11
12
AMBIENT TEMPERATURE (°C)
50
48
46
44
42
40
1000
910a
910b
910c
910d
910e
910f

FIG.26

BACKLIGHT APPARATUS AND LIQUID CRYSTAL DISPLAY APPARATUS

CROSS REFERENCE TO RELATED APPLICATIONS

The disclosures of Japanese Patent Application No. 2008-194048 filed on Jul. 28, 2008, No. 2008-214429 filed on Aug. 22, 2008, and No. 2008-214430 filed on Aug. 22, 2008, including the specifications, drawings and abstracts are incorporated herein by reference in their entirety.

BACKGROUND

1. Technical Field

The technical field relates to a backlight apparatus and liquid crystal display apparatus, and more particularly to an LED (light emitting diode) backlight apparatus in which a plurality of LEDs are placed and a liquid crystal display apparatus having this.

2. Description of the Related Art

There is one kind of liquid crystal display apparatus that illuminates a liquid crystal panel using an LED backlight apparatus (hereinafter referred to simply as "LED backlight").

Unexamined Japanese Patent Publication No. 2007-165632 describes an example of a conventional liquid crystal display apparatus that has an LED backlight. In this liquid crystal display apparatus, control is performed to increase the brightness of some of the LEDs provided in the backlight—for example LEDs placed in an area in which the ambient temperature is high, such as those close to a circuit with a large calorific value—by increasing the amount of drive current or the period for which that current is applied. Backlight brightness is made uniform by means of this control.

However, a property of an LED is that the higher its ambient temperature, the faster is the aging degradation of its brightness and the shorter is its life. Also, increasing the brightness of an LED by increasing its drive current amount or the like is a cause of aging degradation of LED brightness and shortened LED life.

Therefore, when control is performed to increase the drive current amount for LEDs placed in an area in which the ambient temperature is high, as in the case of an above-described conventional liquid crystal display apparatus, the aging degradation of those LEDs is more rapid than that of other LEDs. Consequently, as the cumulative illumination time of those LEDs increases, the brightness of those LEDs becomes lower than that of other LEDs. Therefore, uniformity of backlight brightness cannot be maintained over a long period. In other words, even if uniformity of brightness is maintained in the initial state, that balance is lost after a long period of use.

Also, even if the amount of drive current or the like is increased for LEDs whose brightness decreases to prevent a decrease in the brightness of those LEDs, there is a limit to the increase in the drive current amount, and a situation will eventually arise in which uniformity of brightness cannot be maintained.

SUMMARY

An object is to provide a backlight apparatus and a liquid crystal display apparatus that enable a balance of brightness to be maintained over the entire area of a display screen, and long life to be achieved. A further object is to provide a

backlight apparatus and liquid crystal display apparatus that enable nonuniformity of brightness to be reduced in an outputting surface.

A backlight apparatus achieves the above objects by comprising a substrate having an opposed section opposite the rear surface of a liquid crystal panel, a plurality of light emitting diodes placed on the opposed section, and a current supplying section that supplies to the plurality of light emitting diodes a current that causes the plurality of light emitting diodes to emit light that illuminates the liquid crystal panel; and by having the current supplying section supply a lower current to a light emitting diode placed in an area having a higher ambient temperature within the area of the opposed section.

A backlight apparatus that is used in a liquid crystal display apparatus having a liquid crystal panel and a liquid crystal driver driving the liquid crystal panel, achieves the above objects by comprising a plurality of light emitting diodes placed facing the liquid crystal panel, and a current supplying section that supplies to the plurality of light emitting diodes a current that causes the plurality of light emitting diodes to emit light that illuminates the liquid crystal panel; and by having the current supplying section supply a lower current to a light emitting diode placed nearer the liquid crystal driver.

A backlight apparatus that is used in a liquid crystal display apparatus having a liquid crystal panel as a display screen, achieves the above objects by comprising a plurality of light emitting diodes placed facing the liquid crystal panel, and a current supplying section that supplies to the plurality of light emitting diodes a current that causes the plurality of light emitting diodes to emit light that illuminates the liquid crystal panel; and by having the current supplying section supply a lower current to a light emitting diode placed higher up in the vertical direction of the display screen.

A backlight apparatus that is used in a liquid crystal display apparatus having a liquid crystal panel and a liquid crystal driver driving the liquid crystal panel and a power supply section supplying power to the liquid crystal driver, achieves the above objects by comprising a plurality of light emitting diodes placed facing the liquid crystal panel, and a current supplying section that supplies to the plurality of light emitting diodes a current that causes the plurality of light emitting diodes to emit light that illuminates the liquid crystal panel; and by having the current supplying section supply a lower current to a light emitting diode placed nearer the power supply section.

A backlight apparatus that is used in a liquid crystal display apparatus having a liquid crystal panel as a display screen, achieves the above objects by comprising a plurality of light emitting diodes placed facing the liquid crystal panel, and a current supplying section that supplies to the plurality of light emitting diodes a current that causes the plurality of light emitting diodes to emit light that illuminates the liquid crystal panel; and by having the plurality of light emitting diodes form a plurality of arrays, wherein the plurality of arrays are formed respectively by two or more light emitting diodes arrayed in the vertical direction of the display screen, and are spaced at equal intervals in the horizontal direction of the display screen, and light emitting diodes placed higher up in the vertical direction of the display screen are placed with higher density adjacent to another light emitting diode forming the same array; and by having the current supplying section supply a lower current to a light emitting diode placed higher up in the vertical direction of the display screen.

A backlight apparatus that is used in a liquid crystal display apparatus having a liquid crystal panel as a display screen, achieves the above objects by comprising a plurality of light emitting diodes emitting diodes placed facing the liquid crystal panel, and a current supplying section that supplies to the plurality of light emitting diodes a current that causes the plurality of light emitting diodes to emit light that illuminates the liquid crystal panel; and by having the plurality of light emitting diodes form a plurality of arrays, wherein the plurality of arrays are formed respectively by two or more light emitting diodes arrayed in the horizontal direction of the display screen, and are spaced at equal intervals in the vertical direction of the display screen, and light emitting diodes placed higher up in the vertical direction of the display screen are placed with higher density adjacent to another light emitting diode composing the same array; and by having the current supplying section supply a lower current to a light emitting diode placed higher up in the vertical direction of the display screen.

A backlight apparatus that is used in a liquid crystal display apparatus having a liquid crystal panel as a display screen, achieves the above objects by comprising a substrate having an opposed section placed opposite the rear surface side of the liquid crystal panel, a plurality of light emitting diodes placed with nonuniform placement density on the opposed section, a diffuser plate upon which light emitted from the plurality of light emitting diodes is input and that has a diffusing action on the input light and outputs diffused light toward the liquid crystal panel side, and a current supplying section that supplies to the plurality of light emitting diodes a current that causes the plurality of light emitting diodes to emit light that illuminates the liquid crystal panel; and by having the current supplying section supply a lower current to a light emitting diode placed in an area having a higher ambient temperature within the area of the opposed section, wherein light emitting diodes to which a lower current is supplied are placed with higher density adjacent to another light emitting diode, and the distance between the opposed section and the diffuser plate is greater the lower the placement density of a position.

A backlight apparatus that is used in a liquid crystal display apparatus having a liquid crystal panel as a display screen, achieves the above objects by comprising a substrate having an opposed section placed opposite the rear surface side of the liquid crystal panel, a plurality of light emitting diodes placed with nonuniform placement density on the opposed section, a diffuser plate upon which light emitted from the plurality of light emitting diodes is input and that has a diffusing action on the input light and outputs diffused light toward the liquid crystal panel side, and a current supplying section that supplies to the plurality of light emitting diodes a current that causes the plurality of light emitting diodes to emit light that illuminates the liquid crystal panel; and by having the current supplying section supply a lower current to a light emitting diode placed higher up in the vertical direction of the display screen, wherein light emitting diodes to which a lower current is supplied are placed with higher density adjacent to another light emitting diode, and the distance between the opposed section and the diffuser plate is greater the lower the placement density of a position.

A backlight apparatus that is used in a liquid crystal display apparatus having a liquid crystal panel as a display screen, achieves the above objects by comprising a substrate having an opposed section placed opposite the rear surface side of the liquid crystal panel, a plurality of light emitting diodes placed with nonuniform placement density on the opposed section, a diffuser plate upon which light emitted from the plurality of light emitting diodes is input and that has a diffusing action on the input light and outputs diffused light toward the liquid crystal panel side, and a current supplying section that supplies to the plurality of light emitting diodes a current that causes the plurality of light emitting diodes to emit light that illuminates the liquid crystal panel; and by having the current supplying section supply a lower current to a light emitting diode placed in an area having a higher ambient temperature within the area of the opposed section, wherein light emitting diodes to which a lower current is supplied are placed with higher density adjacent to another light emitting diode, and light emitted from the light emitting diodes is more widely distributed the lower the placement density of a position.

A backlight apparatus that is used in a liquid crystal display apparatus having a liquid crystal panel as a display screen, achieves the above objects by comprising a substrate having an opposed section placed opposite the rear surface side of the liquid crystal panel, a plurality of light emitting diodes placed with nonuniform placement density on the opposed section, a diffuser plate upon which light emitted from the plurality of light emitting diodes is input and that has a diffusing action on the input light and outputs diffused light toward the liquid crystal panel side, and a current supplying section that supplies to the plurality of light emitting diodes a current that causes the plurality of light emitting diodes to emit light that illuminates the liquid crystal panel; and by having the current supplying section supply a lower current to a light emitting diode placed higher up in the vertical direction of the display screen, wherein light emitting diodes to which a lower current is supplied are placed with higher density adjacent to another light emitting diode, and light emitted from the light emitting diodes is more widely distributed the lower the placement density of a position.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects and features of the invention will appear more fully hereinafter from a consideration of the following description taken in conjunction with the accompanying drawings wherein examples are illustrated by way of example, in which:

FIG. **1** is a side view of the principal parts of a liquid crystal display apparatus according to Embodiment 1 of the present invention;

FIG. **2** is a drawing showing an LED array of an LED backlight according to Embodiment 1 of the present invention;

FIG. **3**A is a circuit diagram showing the configuration of an LED drive section according to Embodiment 1 of the present invention;

FIG. **3**B is a waveform diagram showing drive signals according to Embodiment 1 of the present invention;

FIG. **4** is a drawing showing a brightness correction method according to Embodiment 1 of the present invention;

FIG. **5**A is a drawing showing the relationship between ambient temperature and relative brightness for an initial-state LED backlight according to Embodiment 1 of the present invention;

FIG. **5**B is a drawing showing the relationship between ambient temperature and relative brightness for an LED backlight after a predetermined elapse of time according to Embodiment 1 of the present invention;

FIG. **6** is a side view of the principal parts of a liquid crystal display apparatus according to Embodiment 2 of the present invention;

FIG. **7** is a drawing showing an LED array of an LED backlight according to Embodiment 2 of the present invention;

FIG. **8**A is a circuit diagram showing the configuration of an LED drive section according to Embodiment 2 of the present invention;

FIG. **8**B is a waveform diagram showing drive signals according to Embodiment 2 of the present invention;

FIG. **9** is a drawing showing a brightness correction method according to Embodiment 2 of the present invention;

FIG. **10**A is a schematic front view of an LED backlight according to Embodiment 3 of the present invention;

FIG. **10**B is a schematic side view of an LED backlight according to Embodiment 3 of the present invention;

FIG. **11**A is a schematic front view of an LED backlight according to Embodiment 4 of the present invention;

FIG. **11**B is a schematic side view of an LED backlight according to Embodiment 4 of the present invention;

FIG. **12**A is a schematic front view of an LED backlight according to Embodiment 5 of the present invention;

FIG. **12**B is a schematic side view of an LED backlight according to Embodiment 5 of the present invention;

FIG. **13** is a drawing showing the configuration of an LED backlight according to Embodiment 6 of the present invention;

FIG. **14** is a drawing showing the configuration of a liquid crystal display apparatus according to Embodiment 7 of the present invention;

FIG. **15** is a side view of the principal parts of a liquid crystal display apparatus according to Embodiment 8 of the present invention;

FIG. **16** is a drawing showing an LED array of an LED backlight according to Embodiment 8 of the present invention;

FIG. **17**A is a circuit diagram showing the configuration of an LED drive section according to Embodiment 8 of the present invention;

FIG. **17**B is a waveform diagram showing drive signals according to Embodiment 8 of the present invention;

FIG. **18** is a drawing showing a brightness correction method according to Embodiment 8 of the present invention;

FIG. **19**A is a schematic front view of an LED backlight according to Embodiment 9 of the present invention;

FIG. **19**B is a schematic side view of an LED backlight according to Embodiment 9 of the present invention;

FIG. **20** is a drawing comparing the illuminance of emitted light of LEDs having different light distribution characteristics according to Embodiment 9 of the present invention;

FIG. **21** is a drawing showing the configuration of an LED backlight according to Embodiment 10 of the present invention;

FIG. **22** is a drawing showing the configuration of a liquid crystal display apparatus according to Embodiment 11 of the present invention;

FIG. **23** is a side view of the principal parts of a liquid crystal display apparatus according to Embodiment 12 of the present invention;

FIG. **24** is a drawing showing an LED array of an LED backlight according to Embodiment 12 of the present invention;

FIG. **25**A is a circuit diagram showing the configuration of an LED drive section according to Embodiment 12 of the present invention;

FIG. **25**B is a waveform diagram showing drive signals according to Embodiment 12 of the present invention; and

FIG. **26** is a drawing showing a brightness correction method according to Embodiment 12 of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference now to the accompanying drawings, embodiments of the present invention will be explained in detail below.

Embodiment 1

FIG. **1** is a side view of the principal parts of a liquid crystal display apparatus according to Embodiment 1 of the present invention.

Liquid crystal display apparatus **100** has liquid crystal panel **110**, liquid crystal driver **111**, and LED backlight **120** as main components.

Liquid crystal panel **110** is a transmissive or semi-transmissive liquid crystal panel. Liquid crystal panel **110** transmits light emitted from LED backlight **120**, and emits this transmitted light from the front surface of the display screen.

Liquid crystal driver **111** is placed in proximity to the upper edge of liquid crystal panel **110**. In the descriptions of all the embodiments, "upper" means upper in the vertical direction of the display screen (hereinafter referred to simply as "vertical direction") and in FIG. **1** corresponds to the top of the drawing in the vertical direction.

Liquid crystal driver **111** controls a drive voltage that drives liquid crystal panel **110** based on a video signal that is a digital signal indicating video to be displayed on the display screen of liquid crystal panel **110**, and thereby controls the transmittance of liquid crystal panel **110**. As a result of this control, liquid crystal panel **110** displays video.

Liquid crystal driver **111** may be placed in a position other than the above. For example, liquid crystal driver **111** may be placed in proximity to the lower edge, left-hand edge, or right-hand edge of liquid crystal panel **110**, or elsewhere. In the descriptions of all the embodiments, "lower" means lower in the vertical direction, and "left" and "right" mean left and right in the horizontal direction of the display screen (hereinafter referred to simply as "horizontal direction").

LED backlight **120** has substrate **130** placed on the rear surface side of liquid crystal panel **110**. The surface of substrate **130** is an opposed section opposite the rear surface of liquid crystal panel **110**, and LEDs **140***a*, **140***b*, **140***c*, **140***d*, **140***e*, and **140***f* are arrayed on this surface in approximately flat form facing the rear surface of liquid crystal panel **110**. That is to say, LED backlight **120** is a subjacent type of backlight apparatus.

Generally, a subjacent type of backlight apparatus has a sealed structure that can prevent the infiltration of dust or dirt, but LED backlight **120** may or may not employ a sealed structure.

LED backlight **120** illuminates liquid crystal panel **110** with light emitted from LEDs **140***a*, **140***b*, **140***c*, **140***d*, **140***e*, and **140***f*. In the following description, LEDs **140***a*, **140***b*, **140***c*, **140***d*, **140***e*, and **140***f* are referred to simply as "LED(s) **140**" when described without any particular differentiation.

LED backlight **120** also has an LED drive section that drives LEDs **140**, described later herein.

Here, LEDs **140** are white LEDs that emit white light when driven by a drive signal applied from an LED drive section described later herein. For example, when LEDs **140** are LED apparatuses having mainly a monochromatic (for example, blue) LED and a fluorescent material, LEDs **140** are configured so that light emitted from a monochromatic LED when a drive signal is applied is transmitted through the fluorescent material and becomes white light through the action of the fluorescent material.

LEDs **140** may also employ another configuration, such as a combination of LEDs of three colors—R (red) G (green), and B (blue).

The width of the angle of divergence of each LED **140** is set in accordance with the interval between adjacent LEDs **140** so that LED backlight **120** uniformly illuminates the entire area of the display screen.

FIG. **2** is a drawing showing the placement of LEDs **140** in LED backlight **120**.

LEDs **140** are placed so as to form a plurality of arrays on surface area **121** of LED backlight **120**. The formed plurality of arrays are vertical-direction arrays extending in the vertical direction, and in each vertical-direction array, one LED **140***a*, one LED **140***b*, one LED **140***c*, one LED **140***d*, one LED **140***e*, and one LED **140***f* are placed in a straight line in the vertical direction.

In the horizontal direction, there is an equal interval (pitch d_h) between the vertical-direction arrays.

In the vertical direction, LEDs **140** placed in area **122***a* located at the top are placed most densely, LEDs **140** placed in area **122***c* located at the bottom are placed least densely, and LEDs **140** placed in area **122***b* located in the middle are placed with medium density. To be more specific, pitch d_{ab} between LED **140***a* and LED **140***b* is smaller than pitch d_{bc} between LED **140***b* and LED **140***c*, pitch d_{bc} is smaller than pitch d_{cd} between LED **140***c* and LED **140***d*, pitch d_{cd} is smaller than pitch d_{de} between LED **140***d* and LED **140***e*, and pitch d_{de} is smaller than pitch d_{ef} between LED **140***d* and LED **140***f*.

FIG. **3**A and FIG. **3**B are drawings for explaining an LED drive section in LED backlight **120**. FIG. **3**A is a circuit diagram showing an example of the configuration of the LED drive section, and FIG. **3**B is a waveform diagram showing an example of drive signals generated by the LED drive section and supplied to LEDs **140**.

The LED drive section has LED drive circuits **150***a*, **150***b*, **150***c*, **150***d*, **150***e*, and **150***f*. In the following description, LED drive circuits **150***a*, **150***b*, **150***c*, **150***d*, **150***e*, and **150***f* are referred to simply as "LED drive circuit(s) **150**" when described without any particular differentiation.

LED drive circuit **150***a* supplies drive signal **151***a* having preset current value I_a to one LED **140***a* as a current supplying section. LED drive circuit **150***b* supplies drive signal **151***b* having current value I_b to one LED **140***b* as a current supplying section. LED drive circuit **150***c* supplies drive signal **151***c* having current value I_c to one LED **140***c* as a current supplying section. LED drive circuit **150***d* supplies drive signal **151***d* having current value I_d to one LED **140***d* as a current supplying section. LED drive circuit **150***e* supplies drive signal **151***e* having current value I_e to one LED **140***e* as a current supplying section. LED drive circuit **150***f* supplies drive signal **151***f* having current value I_f to one LED **140***f* as a current supplying section.

Although not shown in FIG. **3**A, the LED drive section has the same number of LED drive circuits **150** (as current supplying sections) as LEDs **140**. Each LED drive circuit **150** supplies a drive signal to one LED **140**. By means of this configuration, each LED **140***a* is supplied with drive signal **151***a* having current value I_a, each LED **140***b* is supplied with drive signal **151***b* having current value I_b, each LED **140***c* is supplied with drive signal **151***c* having current value I_c, each LED **140***d* is supplied with drive signal **151***d* having current value I_d, each LED **140***e* is supplied with drive signal **151***e* having current value I_e, and each LED **140***f* is supplied with drive signal **151***f* having current value I_f.

Here, current value I_a is smaller than current value I_b, current value I_b is smaller than current value I_c, current value I_c is smaller than current value I_d, current value I_d is smaller than current value I_e, and current value I_e is smaller than current value I_f. Drive signals **151***a*, **151***b*, **151***c*, **151***d*, **151***e*, and **151***f* all have the same duty cycle.

That is to say, among LEDs **140**, those placed higher up and located nearer liquid crystal driver **111** are supplied with a lower current.

The current value of each LED **140** is set optimally based on the temperature distribution in surface area **121** of LED backlight **120**. For example, in an area (for example, area **122***a*) shown as a high-temperature area in the temperature distribution for a reason such as being located comparatively high up, or being located comparatively near liquid crystal driver **111**, an LED **140** current value is set comparatively low. And in an area (**122***c*) shown as a low-temperature area in the temperature distribution for a reason such as being located comparatively low down, or being located comparatively far from liquid crystal driver **111**, an LED **140** current value is set comparatively high. These settings are made in such a way that the junction temperature becomes equal in all LEDs **140**.

By this means, among LEDs **140**, those placed higher up and located nearer liquid crystal driver **111** emit light at lower brightness. When this kind of drive control is performed, a difference in brightness may occur between individual LEDs **140**. However, since the junction temperatures of all LEDs **140** are equal, no difference in aging degradation progress occurs between individual LEDs **140**. Therefore, even if there is a difference in brightness between LEDs **140**, such a balance of brightness is maintained unchanged over a long period.

Also, among LEDs **140**, those placed higher up, located nearer liquid crystal driver **111**, and supplied with a lower current, are placed with higher density adjacent to another LED **140** forming the same array. For example, the number and placement positions of LEDs **140** of predetermined areas (for example, areas **122***a*, **122***b*, and **122***c*) are set in such a way that luminous flux is equal for each of those predetermined areas.

By this means, uniformity of brightness is realized over the entire area of the display screen, and is maintained unchanged over a long period.

Next, the brightness correction method used in liquid crystal display apparatus **100** will be described.

It is possible to obtain the same kind of effect by making current values I the same, making the duty cycle of drive signal **151***a* smaller than that of drive signal **151***b*, making the duty cycle of drive signal **151***b* smaller than that of drive signal **151***c*, making the duty cycle of drive signal **151***c* smaller than that of drive signal **151***d*, making the duty cycle of drive signal **151***d* smaller than that of drive signal **151***e*, and making the duty cycle of drive signal **151***e* smaller than that of drive signal **151***f*.

FIG. **4** is a drawing for explaining the brightness correction method used in liquid crystal display apparatus **100**. Here, a case is described by way of example in which the ambient temperature of an area located higher up becomes higher during LED **140** illumination.

LEDs **140** are placed with higher density the higher their placement position. Simply by employing this kind of LED placement, a difference in a decrease in LED **140** brightness due to a difference in ambient temperature can be corrected, and brightness can be made uniform over the entire area of the display screen. This is possible even if drive signals with the same current value are supplied to all LEDs **140**.

However, in this embodiment, LED placement is decided in such a way that supposing that drive signals with the same current value are supplied to all LEDs **140**, brightness is higher in an area higher up in the display screen. Thus, when this kind of LED placement is employed, LEDs **140** are supplied with a lower current the higher their placement position. By this means, brightness in the LED **140***a* illumination area (that is, the area of the display screen illuminated by light emitted from all LEDs **140***a*), brightness in the LED **140***b* illumination area, brightness in the LED **140***c* illumination area, brightness in the LED **140***d* illumination area, brightness in the LED **140***e* illumination area, and brightness in the LED **140***f* illumination area, become uniform.

The effect of the brightness correction method shown in FIG. **4** will now be described in greater detail with reference to FIG. **5**A and FIG. **5**B. FIG. **5**A shows an example of the relationship between ambient temperature and relative brightness for initial-state LED backlight **120**, and FIG. **5**B shows an example of the relationship between ambient temperature and relative brightness for LED backlight **120** after use for a predetermined time (for example, 10,000 hours). To simplify the explanation, only LEDs **140***a* and **140***f* are compared.

Warm air from lower areas collects around LEDs **140***a* placed in an upper area, and the temperature rises. This is because liquid crystal display apparatus **100** is generally used in an upright position. Also, the fact that LEDs **140***a* are placed near liquid crystal driver **111**, which generates heat during operation, causes the ambient temperature of LEDs **140***a* to rise compared with that of LEDs **140***f*. Therefore, the brightness of LEDs **140***a* themselves is lower than that of LEDs **140***f*.

Furthermore, LEDs **140***a* are supplied with a lower current than LEDs **140***f* (in the example shown in FIG. **4**, 8.5 mA for LEDs **140***a* compared with 11 mA for LEDs **140***f*). This is a further cause of the brightness of LEDs **140***a* themselves becoming lower than that of LEDs **140***f*.

However, while LEDs **140***a* are placed with high density with respect to LEDs **140***b* (in the example shown in FIG. **4**, the vertical interval (pitch) between LEDs **140***a* and **140***b* is 8 mm), LEDs **140***f* are placed with low density with respect to LEDs **140***e* (in the example shown in FIG. **4**, the vertical interval (pitch) between LEDs **140***e* and **140***f* is 12 mm).

Consequently, in the initial state, characteristics are obtained whereby brightness in the LED **140***a* illumination area falls relatively gently (curve C_{a1}) as the ambient temperature of LEDs **140***a* rises, and brightness in the LED **140***f* illumination area falls relatively markedly (curve C_{f1}) as the ambient temperature of LEDs **140***f* rises.

In this case, when LED backlight **120** is turned on, the ambient temperature of LEDs **140***a* becomes 50° C., and relative brightness in the LED **140***a* illumination area becomes B_1 % (point P_{a1}). Meanwhile, the ambient temperature of LEDs **140***f* becomes 40° C., and relative brightness in the LED **140***f* illumination area becomes B_1 % (point P_{f1}). Thus, brightness is uniform over the entire area of the display screen.

When the cumulative usage time of LED backlight **120** reaches a predetermined time, characteristics are obtained whereby brightness in the LED **140***a* illumination area falls relatively gently (curve C_{a2}) as the ambient temperature of LEDs **140***a* rises, and brightness in the LED **140***f* illumination area falls relatively markedly (curve C_{f2}) as the ambient temperature of LEDs **140***f* rises. Here, comparing curve C_{a1} and curve C_{f1} in FIG. **5**A with curve C_{a2} and curve C_{f2} in FIG. **5**B, it can be seen that aging degradation has occurred in brightness for both LEDs **140***a* and LEDs **140***f*.

In this case, when LED backlight **120** is turned on, the ambient temperature of LEDs **140***a* becomes 50° C., and relative brightness in the LED **140***a* placement area becomes B_2 % (point P_{a2}). Meanwhile, the ambient temperature of LEDs **140***f* becomes 40° C., and relative brightness in the LED **140***f* placement area becomes B_2 % (point P_{f2}). That is to say, although aging degradation of brightness has occurred in both areas, since the degree of progress is the same for both, uniformity of brightness is maintained over the entire area of the display screen. This is because the progress of aging degradation of LEDs **140** is slowed by supplying a relatively low current to LEDs **140** (in this example, LEDs **140***a*) whose aging degradation should be relatively rapid due to the fact that the ambient temperature is relatively high.

As described above, according to this embodiment, a lower current is supplied to LEDs **140** placed in an area with a higher ambient temperature within surface area **121** of substrate **130** of LED backlight **120**. By this means, the progress of aging degradation of all LEDs **140** provided in LED backlight **120** is made uniform. Therefore, the balance of brightness over the entire area of the display screen can be maintained over a long period. Also, according to this embodiment, control to slow aging degradation (that is, supply of a relatively low current) is performed for those of LEDs **140** for which aging degradation should be relatively rapid due to a relatively high ambient temperature. Therefore, the life of LED backlight **120** can be prolonged.

Furthermore, according to this embodiment, since array gaps are uniform in the horizontal direction and LED **140** gaps are nonuniform in the vertical direction, there is an advantage of being able to achieve commonality of LED drive control circuitry due to the fact that the number of horizontal LEDs is the same.

In this embodiment, a case has been described by way of example in which the ambient temperature of an area higher up is higher, and a configuration has been described in which LEDs **140** placed in an area higher up are placed with higher density, and are driven by a lower current. However, other configurations are also possible.

For example, if liquid crystal driver **111** is placed in proximity to the lower edge of liquid crystal panel **110**, so that the ambient temperature of a lower area becomes higher than that of an area above, a configuration can be employed in which LEDs **140** placed in a lower area are placed with higher density, and are driven by a lower current.

Also, if liquid crystal driver **111** is placed in proximity to the left-hand edge of liquid crystal panel **110**, so that the ambient temperature of an area to the left becomes higher than that of an area to the right, a configuration can be employed in which LEDs **140** placed in an area to the left are placed with higher density, and are driven by a lower current.

Also, if liquid crystal driver **111** is placed in proximity to the right-hand edge of liquid crystal panel **110**, so that the ambient temperature of an area to the right becomes higher than that of an area to the left, a configuration can be employed in which LEDs **140** placed in an area to the right are placed with higher density, and are driven by a lower current.

Essentially, when the ambient temperature of an area near liquid crystal driver **111** becomes higher than the ambient temperature of an area farther away, a configuration can be employed in which LEDs **140** placed in the former area are placed with higher density, and are driven by a lower current.

Exactly the same applies to a power supply section—that is, power supply circuitry supplying power to liquid crystal driver **111**, LED drive circuits **150**, and so forth—and to other heat-generating members, as to liquid crystal driver **111**. This is because a power supply section and the like also generate heat. Thus, the placement and drive current values of LEDs **140** can be decided according to the placement positions of a power supply section and so forth.

Even if there is temperature distribution such that the ambient temperature of an area higher up does not become higher due to the internal structure of liquid crystal display apparatus **100**, the placement and drive current values of LEDs **140** can still be decided based on that temperature distribution.

In this embodiment, LEDs **140** are white LEDs, but the same kind of effect as described above can also be realized if LEDs **140** are a combination of LEDs of three colors—R (red), G (green), and B (blue). In this case, a configuration is employed in which more red LEDs, which decrease greatly in brightness due to temperature, are placed in a high-temperature area than green or blue LEDs. By this means, the color temperature balance can also be maintained over a long period.

According to this embodiment, LEDs **140** are placed so as to form linear arrays, but the LED **140** placement scheme is not limited to this. Various kinds of placement schemes can be employed, such as placing LEDs **140** so as to form zigzag arrays, for example.

If illumination of LED backlight **120** is interlinked with a liquid crystal panel **110** screen display scan and a backlight scan is performed to improve liquid crystal moving image performance, it is necessary to take account of the fact that the pitch differs in the LED vertical direction, and perform control of the LED backlight **120** illumination start time interlinked with the scan.

Embodiment 2

FIG. **6** is a side view of the principal parts of a liquid crystal display apparatus according to Embodiment 2 of the present invention. Configuration elements identical to those in Embodiment 1 are assigned the same reference codes as in Embodiment 1, and detailed descriptions thereof are omitted here.

This embodiment differs from Embodiment 1 in the LED placement scheme.

Liquid crystal display apparatus **200** has liquid crystal panel **110**, liquid crystal driver **111**, and LED backlight **220** as main components.

LED backlight **220** has substrate **230** placed on the rear surface side of liquid crystal panel **110**. The surface of substrate **230** is an opposed section opposite the rear surface of liquid crystal panel **110**, and LEDs **240***a*, **240***b*, **240***c*, **240***d*, **240***e*, and **240***f* are arrayed on this surface in approximately flat form facing the rear surface of liquid crystal panel **110**. That is to say, LED backlight **220** is a subjacent type of backlight apparatus.

Generally, a subjacent type of backlight apparatus has a sealed structure that can prevent the infiltration of dust or dirt, but LED backlight **220** may or may not employ a sealed structure.

LED backlight **220** illuminates liquid crystal panel **110** with light emitted from LEDs **240***a*, **240***b*, **240***c*, **240***d*, **240***e*, and **240***f*. In the following description, LEDs **240***a*, **240***b*, **240***c*, **240***d*, **240***e*, and **240***f* are referred to simply as "LED(s) **240**" when described without any particular differentiation.

LED backlight **220** also has an LED drive section that drives LEDs **240**, described later herein.

Here, LEDs **240** are white LEDs that emit white light when driven by a drive signal applied from an LED drive section described later herein. For example, when LEDs **240** are LED apparatuses having mainly a monochromatic (for example, blue) LED and a fluorescent material, LEDs **240** are configured so that light emitted from a monochromatic LED when a drive signal is applied is transmitted through the fluorescent material and becomes white light through the action of the fluorescent material.

LEDs **240** may also employ another configuration, such as a combination of LEDs of three colors—R (red) G (green), and B (blue).

The width of the angle of divergence of each LED **240** is set in accordance with the interval between adjacent LEDs **240** so that LED backlight **220** uniformly illuminates the entire area of the display screen.

FIG. **7** is a drawing showing the placement of LEDs **240** in LED backlight **220**.

LEDs **240** are placed so as to form a plurality of arrays on surface area **221** of LED backlight **220**. The formed plurality of arrays are horizontal-direction arrays extending in the horizontal direction, with all LEDs **240***a* placed linearly in the horizontal direction, all LEDs **240***b* placed linearly in the horizontal direction, all LEDs **240***c* placed linearly in the horizontal direction, all LEDs **240***d* placed linearly in the horizontal direction, all LEDs **240***e* placed linearly in the horizontal direction, and all LEDs **240***f* placed linearly in the horizontal direction.

In the vertical direction, there is an equal interval (pitch d_v) between the horizontal-direction arrays.

In the horizontal direction, the placement density of LEDs **240***a* in area **222***a* located at the top is highest, the placement density of LEDs **240***b* in area **222***b* therebelow is next highest, the placement density of LEDs **240***c* in area **222***c* therebelow is next highest, the placement density of LEDs **240***d* in area **222***d* therebelow is next highest, the placement density of LEDs **240***e* in area **222***e* therebelow is next highest, and the placement density of LEDs **240***f* in area **222***f* at the bottom is lowest. In other words, pitch d_a between LEDs **240***a* is smaller than pitch d_b between LEDs **240***b*, pitch d_b is smaller than pitch d_c between LEDs **240***c*, pitch d_c is smaller than pitch d_d between LEDs **240***d*, pitch d_d is smaller than pitch d_e between LEDs **240***e*, and pitch d_e is smaller than pitch d_f between LEDs **240***f*.

FIG. **8**A and FIG. **8**B are drawings for explaining an LED drive section in LED backlight **220**. FIG. **8**A is a circuit diagram showing an example of the configuration of the LED drive section, and FIG. **8**B is a waveform diagram showing an example of drive signals generated by the LED drive section and supplied to LEDs **240**.

In the LED drive section shown in FIG. **8**A and FIG. **8**B, LED drive circuit **150***a* supplies drive signal **151***a* having preset current value I_a to one LED **240***a* as a current supplying section; LED drive circuit **150***b* supplies drive signal **151***b* having current value I_b to one LED **240***b* as a current supplying section; LED drive circuit **150***c* supplies drive signal **151***c* having current value I_c to one LED **240***c* as a current supplying section; LED drive circuit **150***d* supplies drive signal **151***d* having current value I_d to one LED **240***d* as a current supplying section; LED drive circuit **150***e* supplies drive signal **151***e* having current value I_e to one LED **240***e* as a current supplying section; and LED drive circuit **150***f* supplies drive signal **151***f* having current value I_f to one LED **240***f* as a current supplying section.

Although not shown in FIG. **8**A, the LED drive section has the same number of LED drive circuits **150** (as current supplying sections) as LEDs **240**. Each LED drive circuit **150** supplies a drive signal to one LED **240**. By means of this configuration, each LED **240***a* is supplied with drive signal **151***a* having current value I_a, each LED **240***b* is supplied with drive signal **151***b* having current value I_b, each LED **240***c* is supplied with drive signal **151***c* having current value I_c, each LED **240***d* is supplied with drive signal **151***d* having current value I_d, each LED **240***e* is supplied with drive signal **151***e* having current value I_e, and each LED **240***f* is supplied with drive signal **151***f* having current value I_f.

Here, current value I_a is smaller than current value I_b, current value I_b is smaller than current value I_c, current value I_c is smaller than current value I_d, current value I_d is smaller than current value I_e, and current value I_e is smaller than current value I_f. Drive signals **151***a*, **151***b*, **151***c*, **151***d*, **151***e*, and **151***f* all have the same duty cycle.

That is to say, among LEDs **240**, those placed higher up and located nearer liquid crystal driver **111** are supplied with a lower current.

The current value of each LED **240** is set optimally based on the temperature distribution in surface area **221** of LED backlight **220**. For example, in an area (for example, area **222***a*) shown as a high-temperature area in the temperature distribution for a reason such as being located comparatively high up, or being located comparatively near liquid crystal driver **111**, an LED **240** current value is set comparatively low. And in an area (**222***f*) shown as a low-temperature area in the temperature distribution for a reason such as being located comparatively low down, or being located comparatively far from liquid crystal driver **111**, an LED **240** current value is set comparatively high. These settings are made in such a way that the junction temperature becomes equal in all LEDs **240**.

By this means, among LEDs **240**, those placed higher up and located nearer liquid crystal driver **111** emit light at lower brightness. When this kind of drive control is performed, a difference in brightness may occur between individual LEDs **240**. However, since the junction temperatures of all LEDs **240** are equal, no difference in aging degradation progress occurs between individual LEDs **240**. Therefore, even if there is a difference in brightness between LEDs **240**, such a balance of brightness is maintained unchanged over a long period.

Also, among LEDs **240**, those placed higher up, located nearer liquid crystal driver **111**, and supplied with a lower current, are placed with higher density adjacent to another LED **240** forming the same array. For example, the number and placement positions of LEDs **240** of predetermined areas (for example, areas **222***a*, **222***b*, **222***c*, **222***d*, **222***e*, and **122***f*) are set in such a way that luminous flux is equal for each of those predetermined areas.

By this means, uniformity of brightness is realized over the entire area of the display screen, and is maintained unchanged over a long period.

It is possible to obtain the same kind of effect by making current values I the same, making the duty cycle of drive signal **151***a* smaller than that of drive signal **151***b*, making the duty cycle of drive signal **151***b* smaller than that of drive signal **151***c*, making the duty cycle of drive signal **151***c* smaller than that of drive signal **151***d*, making the duty cycle of drive signal **151***d* smaller than that of drive signal **151***e*, and making the duty cycle of drive signal **151***e* smaller than that of drive signal **151***f*.

Next, the brightness correction method used in liquid crystal display apparatus **200** will be described.

FIG. **9** is a drawing for explaining the brightness correction method used in liquid crystal display apparatus **200**. Here, a case is described by way of example in which the ambient temperature of an area located higher up becomes higher during LED **240** illumination.

LEDs **240** are placed with higher density the higher their placement position. Simply by employing this kind of LED placement, a difference in a decrease in LED **240** brightness due to a difference in ambient temperature can be corrected, and brightness can be made uniform over the entire area of the display screen. This is possible even if drive signals with the same current value are supplied to all LEDs **240**.

However, in this embodiment, LED placement is decided in such a way that supposing that drive signals with the same current value are supplied to all LEDs **240**, brightness is higher in an area higher up in the display screen. Thus, when this kind of LED placement is employed, LEDs **240** are supplied with a lower current the higher their placement position. By this means, brightness in the LED **240***a* illumination area (that is, the area of the display screen illuminated by light emitted from all LEDs **240***a*), brightness in the LED **240***b* illumination area, brightness in the LED **240***c* illumination area, brightness in the LED **240***d* illumination area, brightness in the LED **240***e* illumination area, and brightness in the LED **240***f* illumination area, become uniform.

As described above, according to this embodiment, a lower current is supplied to LEDs **240** placed in an area with a higher ambient temperature within surface area **221** of substrate **230** of LED backlight **220**. By this means, the progress of aging degradation of all LEDs **240** provided in LED backlight **220** is made uniform. Therefore, the balance of brightness over the entire area of the display screen can be maintained over a long period. Also, according to this embodiment, control to slow aging degradation (that is, supply of a relatively low current) is performed for those of LEDs **240** for which aging degradation should be relatively rapid due to a relatively high ambient temperature. Therefore, the life of LED backlight **220** can be prolonged.

Furthermore, according to this embodiment, since array gaps are uniform in the vertical direction and LED **240** gaps are nonuniform in the horizontal direction, it is possible to achieve an improvement in liquid crystal moving image performance by means of a backlight scan with the same kind of timing as heretofore.

In this embodiment, a case has been described by way of example in which the ambient temperature of an area higher up is higher, and a configuration has been described in which LEDs **240** placed in an area higher up are placed with higher density, and are driven by a lower current. However, other configurations are also possible.

For example, if liquid crystal driver **111** is placed in proximity to the lower edge of liquid crystal panel **110**, so that the ambient temperature of a lower area becomes higher than that of an area above, a configuration can be employed in which LEDs **240** placed in a lower area are placed with higher density, and are driven by a lower current.

Also, if liquid crystal driver **111** is placed in proximity to the left-hand edge of liquid crystal panel **110**, so that the ambient temperature of an area to the left becomes higher than that of an area to the right, a configuration can be employed in which LEDs **240** placed in an area to the left are placed with higher density, and are driven by a lower current.

Also, if liquid crystal driver **111** is placed in proximity to the right-hand edge of liquid crystal panel **110**, so that the ambient temperature of an area to the right becomes higher than that of an area to the left, a configuration can be employed in which LEDs **240** placed in an area to the right are placed with higher density, and are driven by a lower current.

Essentially, when the ambient temperature of an area near liquid crystal driver **111** becomes higher than the ambient temperature of an area farther away, a configuration can be employed in which LEDs **240** placed in the former area are placed with higher density, and are driven by a lower current.

Exactly the same applies to a power supply section—that is, power supply circuitry supplying power to liquid crystal driver **111**, LED drive circuits **150**, and so forth—and to other heat-generating members, as to liquid crystal driver **111**. This is because a power supply section and the like also generate heat. Thus, the placement and drive current values of LEDs **240** can be decided according to the placement positions of a power supply section and so forth.

Even if there is temperature distribution such that the ambient temperature of an area higher up does not become higher due to the internal structure of liquid crystal display apparatus **200**, the placement and drive current values of LEDs **240** can still be decided based on that temperature distribution.

In this embodiment, LEDs **240** are white LEDs, but the same kind of effect as described above can also be realized if LEDs **240** are a combination of LEDs of three colors—R (red), G (green), and B (blue). In this case, a configuration is employed in which more red LEDs, which decrease greatly in brightness due to temperature, are placed in a high-temperature area than green or blue LEDs. By this means, the color temperature balance can also be maintained over a long period.

According to this embodiment, LEDs **240** are placed so as to form linear arrays, but the LED **240** placement scheme is not limited to this. Various kinds of placement schemes can be employed, such as placing LEDs **240** so as to form zigzag arrays, for example.

Embodiment 3

FIG. **10**A and FIG. **10**B are drawings showing the configuration of an LED backlight (backlight apparatus) according to Embodiment 3 of the present invention. FIG. **10**A is a schematic front view of the LED backlight, and FIG. **10**B is a schematic side view of the LED backlight. This embodiment relates, for example, to an LED backlight that is used as a liquid crystal display backlight and is configured so that brightness at the top of the screen is made particularly high when the liquid crystal display is set up so that the screen is vertical. A vertical direction in FIG. **10**A and FIG. **10**B corresponds to a vertical direction when the liquid crystal display apparatus in which the LED backlight is used is set up—that is, the vertical direction of the screen.

In FIG. **10**A and FIG. **10**B, LED backlight **300** has a plurality of LEDs **310**, substrate **320** on which plurality of LEDs **310** are placed, and diffuser plate **330** placed on the light emitting side of LEDs **310**, as main components. A plurality of LEDs **310** are white LEDs, for example. Substrate **320** is a flat printed circuit board using a material having insulating properties, such as glass epoxy resin. Diffuser plate **330** is a flat acrylic sheet, having inputting surface **331** upon which light emitted from plurality of LEDs **310** is input, and outputting surface **332** placed opposite inputting surface **331**. Diffuser plate **330** diffuses light input upon inputting surface **331** by means of surface diffusion, internal diffusion, or a combination thereof, and outputs light from outputting surface **332**.

LEDs **310** are placed with progressively higher density toward the top of diffuser plate **330** in the drawings. Specifically, LEDs **310** are installed on substrate **320** with a placement density inversely proportional to their distance from the top of diffuser plate **330**.

Substrate **320** is placed at an inclined angle with respect to diffuser plate **330** so that the distance from diffuser plate **330** increases in the downward direction in the drawings. By this means, the distance from LEDs **310** to inputting surface **331** of diffuser plate **330** (hereinafter referred to as the "light source distance") increases progressively in the downward direction in the drawings.

Here, it is assumed that the light source distance is set so that a value obtained by multiplying the placement density by the square of the light source distance is constant. This is based on the fact that, if the shortest light source distance at which brightness nonuniformity attains a permissible level with LEDs **310** arranged in a square array with a pitch of d is designated T, pitch d and shortest light source distance T have a proportional relationship. If the ratio between pitch d and shortest light source distance T is designated α, LED backlight **300** satisfies Equation (1) below.

$$T/d=\alpha \tag{1}$$

In this case, placement density D=1/d^2. Therefore, if the relationship between density D and shortest light source distance T is expressed as α^2=k, Equation (2) below is satisfied.

$$D\times T\hat{}2=k \tag{2}$$

With LED backlight **300** of this embodiment, as the placement density changes in the downward direction, inclined placement is implemented, and the light source distance changes so as to become a light source distance for which nonuniformity of brightness is at a permissible level in each area range. If the light source distance and placement density of LEDs **310** located at the top are designated Th and Dh respectively, and the light source distance and placement density of LEDs **310** located at the bottom are designated Tl and Dl respectively, LED backlight **300** satisfies Equation (3) below.

$$k=Dh\times Th\hat{}2=Dl\times Tl\hat{}2 \tag{3}$$

An example of numeric values that satisfy Equation (3) is shown below. Placement densities Dh and Dl are based on square areas with 50 mm sides on substrate **320**, and distances Th and Tl are distances from the centers of the square areas to inputting surface **331** of diffuser plate **330**.

k=0.64

Dh=0.0064 [units/mm^2]

Dl=0.0016 [units/mm^2]

Th=10 [mm]

Tl=20 [mm]

By configuring LED backlight **300** so as to satisfy above Equation (3), nonuniformity of brightness of outputting surface **332** is reduced as compared with a configuration in which the light source distance is constant, and as compared with a configuration in which the light source distance becomes progressively shorter in the downward direction in the drawings.

As described above, according to this embodiment, the lower the placement density of a position, the greater is the distance from LEDs **310** to diffuser plate **330**, and the wider is the diffusion of light that is emitted from a light source and is input upon diffuser plate **330**. By this means, an irradiated area in inputting surface **331** of diffuser plate **330** increases, enabling nonuniformity of brightness in outputting surface **332** of diffuser plate **330** to be reduced.

Also, since the placement density of LEDs **310** is inversely proportional to the distance from the top of diffuser plate **330**, the above-described reduction in nonuniformity of brightness can be realized by simple settings—namely, settings of the light source distance of LEDs **310** located at the top and the light source distance of LEDs **310** located at the bottom.

Furthermore, since nonuniformity of brightness can be reduced when the placement density of LEDs **310** is high at the top of diffuser plate **330**, nonuniformity of brightness can be reduced when high brightness is secured at the top of diffuser plate **330**. That is to say, LED backlight **300** can be provided that achieves both a reduction in nonuniformity of brightness of outputting surface **332** and an improvement in the brightness of the upper part of outputting surface **332**.

Moreover, since the external shape of LED backlight **300** can be made a wedge shape that is thin at the top, a liquid crystal display apparatus using LED backlight **300** is advantageous in terms of design characteristics and set-up stability.

In this embodiment, the high/low placement density variation trend of LEDs **310** is not limited to what has been described above. For example, in a case in which high brightness is secured at the bottom of diffuser plate **330**, nonuniformity of brightness can be similarly reduced by inclining substrate **320** so that the light source distance increases the lower the placement density of a position.

Embodiment 4

As Embodiment 4 of the present invention, a case will be described in which LED placement density is inversely proportional to the distance from a vertically central part of a diffuser plate.

FIG. **11**A and FIG. **11**B are drawings showing the configuration of an LED backlight according to Embodiment 4 of the present invention, and correspond to FIG. **10**A and FIG. **10**B of Embodiment 3. Components identical to those in FIG. **10**A and FIG. **10**B are assigned the same reference codes as in FIG. **10**A and FIG. **10**B, and descriptions thereof are omitted here. FIG. **11**A is a schematic front view of the LED backlight, and FIG. **11**B is a schematic side view of the LED backlight.

As shown in FIG. **11**A and FIG. **11**B, LEDs **310** are placed in LED backlight **400** with progressively higher density the nearer they are to the vertically central part of diffuser plate **330** in the drawings. Specifically, LEDs **310** are installed on substrate **420** described later herein with a placement density inversely proportional to their distance from the vertical-direction center of diffuser plate **330**.

Substrate **420** is of cylindrical shape having a convex surface on the diffuser plate **330** side, so that the distance from diffuser plate **330** increases progressively the farther away from the vertically central part in the drawings. As a result of this shape of substrate **420**, the area of the irradiation range of individual LEDs **310** increases the greater the distance from the vertically central part of diffuser plate **330**—that is, the lower the LED **310** placement density of a position.

Here, as in Embodiment 3, it is assumed that the light source distance is set so that a value obtained by multiplying the light source distance by the square of the placement density is constant. That is to say, if the light source distance and placement density of LEDs **310** located in the vertically central part of diffuser plate **330** are designated Tc and Dc respectively, and the light source distance and placement density of LEDs **310** located at the top and LEDs **310** located at the bottom are designated Te and De respectively, LED backlight **400** satisfies Equation (4) below.

$$k=Dc\times Tc\hat{\ }2=De\times Te\hat{\ }2 \quad (4)$$

An example of numeric values that satisfy Equation (4) is shown below.

k=0.64

Dc=0.0064 [units/mm^2]

De=0.0025 [units/mm^2]

Tc=10 [mm]

Te=16 [mm]

Thus, according to this embodiment, since the light source distance varies according to the placement density, LED backlight **400** can be provided that achieves both an improvement in brightness and a reduction in nonuniformity of brightness of the vertically central part of outputting surface **332**.

In this embodiment, the high/low placement density variation trend of LEDs **310** is not limited to what has been described above. For example, in a case in which high brightness is secured in the horizontal central part of diffuser plate **330**, nonuniformity of brightness can be similarly reduced by setting the shape of the substrate so that the light source distance increases the lower the placement density of a position.

Embodiment 5

As Embodiment 5 of the present invention, a case will be described in which LED placement density is proportional to the distance from a vertically central part of a diffuser plate.

FIG. **12**A and FIG. **12**B are drawings showing the configuration of an LED backlight according to Embodiment 5 of the present invention, and correspond to FIG. **10**A and FIG. **10**B of Embodiment 3 and to FIG. **11**A and FIG. **11**B of Embodiment 4. Components identical to those in FIG. **10**A, FIG. **10**B, FIG. **11**A, and FIG. **11**B are assigned the same reference codes as in FIG. **10**A, FIG. **10**B, FIG. **11**A, and FIG. **11**B, and descriptions thereof are omitted here. FIG. **12**A is a schematic front view of the LED backlight, and FIG. **12**B is a schematic side view of the LED backlight.

As shown in FIG. **12**A and FIG. **12**B, LEDs **310** are placed in LED backlight **500** with progressively higher density the farther they are from the vertically central part of diffuser plate **330** in the drawings. Specifically, LEDs **310** are installed on substrate **520** described later herein with a placement density proportional to their distance from the vertical-direction center of diffuser plate **330**.

Substrate **520** is of cylindrical shape having a concave surface on the diffuser plate **330** side, so that the distance from diffuser plate **330** increases progressively the nearer the vertically central part in the drawings. As a result of this shape of substrate **520**, the area of the irradiation range of individual LEDs **310** increases the shorter the distance from the vertically central part of diffuser plate **330**—that is, the lower the LED **310** placement density of a position.

Here, it is assumed that the light source distance is set so that a value obtained by multiplying the light source distance by the square of the placement density is constant. That is to say, if the light source distance and placement density of LEDs **310** located in the vertically central part of diffuser plate **330** are designated Tc and Dc respectively, and the light source distance and placement density of LEDs **310** located at the top and LEDs **310** located at the bottom are designated Te and De respectively, LED backlight **500** satisfies Equation (5) below.

$$k=Dc\times Tc\hat{\ }2=De\times Te\hat{\ }2 \quad (5)$$

An example of numeric values that satisfy Equation (5) is shown below.

k=0.64

Dc=0.0025 [units/mm^2]

De=0.0064 [units/mm^2]

Tc=16 [mm]

Te=10 [mm]

Thus, according to this embodiment, nonuniformity of brightness can be reduced when LED **310** placement density is high in a peripheral part in the vertical direction of diffuser plate **330**, and therefore nonuniformity of brightness can be reduced when high brightness is secured in a peripheral part in the vertical direction of diffuser plate **330**. That is to say, LED backlight **500** can be provided that achieves both a reduction in nonuniformity of brightness of outputting surface **332** and an improvement in the brightness of a peripheral part in the vertical direction of outputting surface **332**.

In this embodiment, the high/low placement density variation trend of LEDs **310** is not limited to what has been described above. For example, in a case in which high brightness is secured in a peripheral part in the horizontal direction of diffuser plate **330**, nonuniformity of brightness can be similarly reduced by setting the shape of the substrate so that the light source distance increases the lower the placement density of a position.

Embodiment 6

As Embodiment 6 of the present invention, an LED backlight will be described that provides for control of the amount of luminescence of LEDs.

FIG. **13** is a schematic configuration diagram drawing showing the configuration of an LED backlight according to Embodiment 6 of the present invention.

In FIG. **13**, LED backlight **600** has a plurality of LEDs **310** placed with uniform placement density in the horizontal direction and with nonuniform placement density in the vertical direction. That is to say, the LED **310** placement density distribution is of the same kind as in Embodiment 3. Also, LED backlight **600** has LED drive section **640** that controls the amount of luminescence of plurality of LEDs **310**.

Taking a plurality of LEDs **310** aligned in the horizontal direction as one block, LED drive section **640** controls the amount of luminescence of each LED **310** on a block-by-block basis according to an input control signal.

By means of this kind of configuration, control of the amount of luminescence of LEDs **310** can be performed in a manner appropriate to the LED **310** placement density distribution, and a desired brightness distribution can be obtained efficiently.

Embodiment 7

As Embodiment 7 of the present invention, a liquid crystal display apparatus will be described that uses an LED backlight according to Embodiment 6.

FIG. **14** is a schematic configuration diagram showing the configuration of a liquid crystal display apparatus according to Embodiment 7 of the present invention.

In FIG. **14**, liquid crystal display apparatus **700** has LED backlight **600** according to Embodiment 6 and liquid crystal unit **750**. Components identical to those in FIG. **13** are assigned the same reference codes as in FIG. **13**, and descriptions thereof are omitted here.

Liquid crystal unit **750** is illuminated by LED backlight **600**, and controls the arrival on the observer's side of light emitted from LED backlight **600**. Liquid crystal unit **750** has liquid crystal panel **751** and liquid crystal driver **752**.

Liquid crystal panel **751** is a transmissive or semi-transmissive liquid crystal panel. Liquid crystal panel **751** transmits light emitted from LED backlight **600**, and emits this transmitted light from the front surface of the display screen.

Liquid crystal driver **752** controls a drive voltage that drives liquid crystal panel **751** based on a video signal that is a digital signal indicating video to be displayed on the display screen of liquid crystal panel **751**, and thereby controls the transmittance of liquid crystal panel **751**. As a result of this control, liquid crystal panel **751** displays video.

LED backlight **600** controls the amount of luminescence of LEDs **310** on a block-by-block basis as described in Embodiment 6. On the other hand, light transmittance cannot be made zero for liquid crystal panel **751**. Therefore, by minimizing the amount of luminescence of LEDs **310** on a block-by-block basis, black brightness—the brightness of a black display part of the screen—can be reduced, and an improvement in screen contrast can be achieved.

Thus, according to this embodiment, video having a desired brightness distribution without nonuniformity of brightness can be displayed with a high degree of contrast, and power consumption can be reduced. Also, when LED backlight **600** having a wedge shape that is thin at the top is employed as described above, the external shape of liquid crystal display apparatus **700** can also be made the same kind of wedge shape, which is advantageous in terms of design characteristics and set-up stability.

In the above-described embodiments, cases have been described in which a light source is an LED, but the present invention is not limited to this. For example, the present invention can also be applied to cases in which light sources are of various kinds, such as a semiconductor laser, gas laser, solid-state laser, fiber laser, lamp, and so forth, and various kinds of line light sources of a cathode ray tube or the like are placed with nonuniform distribution.

Embodiment 8

As Embodiment 8 of the present invention, a liquid crystal display apparatus that is distinctive in regard to liquid crystal driver placement and operation of the LED drive section will be described.

FIG. **15** is a side view of the principal parts of a liquid crystal display apparatus according to Embodiment 8 of the present invention, and corresponds to FIG. **10**B of Embodiment 3 and FIG. **14** of Embodiment 7. Components identical to those in FIG. **10**B and FIG. **14** are assigned the same reference codes as in FIG. **10**B and FIG. **14**, and descriptions thereof are omitted here.

Liquid crystal display apparatus **800** has liquid crystal panel **751**, liquid crystal driver **752**, and LED backlight **600** as main components.

In this embodiment, liquid crystal driver **752** is placed in proximity to the upper edge of liquid crystal panel **751**.

Liquid crystal driver **752** may also be placed in a location other than the above. For example, liquid crystal driver **752** may be placed in proximity to the lower edge, left-hand edge, or right-hand edge of liquid crystal panel **751**, or may be placed elsewhere.

In LED backlight **600**, substrate **320** is placed at an inclined angle to diffuser plate **330** placed on the rear surface side of liquid crystal panel **751**, in the same way as in Embodiment 3. The surface of substrate **320** is an opposed section opposite the rear surface of liquid crystal panel **751**, and LEDs **310***a*, **310***b*, **310***c*, **310***d*, **310***e*, and **310***f* are arrayed on this surface in approximately flat form facing the rear surface of diffuser plate **330**. Diffuser plate **330** has a diffusing action on the input light, and outputs light from the outputting surface toward the rear surface of liquid crystal panel **751**. That is to say, LED backlight **600** is a subjacent type of backlight apparatus.

Generally, a subjacent type of backlight apparatus has a sealed structure that can prevent the infiltration of dust or dirt, but LED backlight **600** may or may not employ a sealed structure.

LED backlight **600** illuminates liquid crystal panel **751** with light emitted from LEDs **310***a*, **310***b*, **310***c*, **310***d*, **310***e*, and **310***f*. In the following description, LEDs **310***a*, **310***b*, **310***c*, **310***d*, **310***e*, and **310***f* are referred to simply as "LED(s) **310**" when described without any particular differentiation.

LED backlight **600** also has an LED drive section that drives LEDs **310**, described later herein.

Here, LEDs **310** are white LEDs that emit white light when driven by a drive signal applied from an LED drive section described later herein. For example, when LEDs **310** are LED apparatuses having mainly a monochromatic (for example, blue) LED and a fluorescent material, LEDs **310** are configured so that light emitted from a monochromatic LED when a drive signal is applied is transmitted through the fluorescent material and becomes white light through the action of the fluorescent material.

LEDs **310** may also employ another configuration, such as a combination of LEDs of three colors—R (red) G (green), and B (blue).

FIG. **16** is a drawing showing the placement of LEDs **310** in LED backlight **600**.

LEDs **310** placed in area **601***a* located at the top are placed most densely, LEDs **310** placed in area **601***c* located at the bottom are placed least densely, and LEDs **310** placed in area **601***b* located in the middle are placed with medium density. To be more specific, in the vertical direction, pitch d_{ab} between LED **310***a* and LED **310***b* is smaller than pitch d_{bc} between LED **310***b* and LED **310***c*, pitch d_{bc} is smaller than pitch d_{cd} between LED **310***c* and LED **310***d*, pitch d_{cd} is smaller than pitch d_{de} between LED **310***d* and LED **310***e*, and pitch d_{de} is smaller than pitch d_{ef} between LED **310***d* and LED **310***f*. Also, in the horizontal direction, the pitch of LEDs **310***a* is smaller than the pitch of LEDs **310***b*, the pitch of LEDs **310***b* is smaller than the pitch of LEDs **310***c*, the pitch of LEDs **310***c* is smaller than the pitch of LEDs **310***d*, the pitch of LEDs **310***d* is smaller than the pitch of LEDs **310***e*, and the pitch of LEDs **310***e* is smaller than the pitch of LEDs **310***f*.

Substrate **320** is placed at an inclined angle with respect to diffuser plate **330** so that the distance from diffuser plate **330** increases in the downward direction in the drawing. By this means, the distance from LEDs **310** to the inputting surface of diffuser plate **330** (the light source distance) increases progressively in the downward direction in the drawing.

FIG. **17**A and FIG. **17**B are drawings for explaining an LED drive section in LED backlight **600**. FIG. **17**A is a circuit diagram showing an example of the configuration of the LED drive section, and FIG. **17**B is a waveform diagram showing an example of drive signals generated by the LED drive section and supplied to LEDs **310**.

LED drive section **840** has LED drive circuits **841***a*, **841***b*, **841***c*, **841***d*, **841***e*, and **841***f*. In the following description, LED drive circuits **841***a*, **841***b*, **841***c*, **841***d*, **841***e*, and **841***f* are referred to simply as "LED drive circuit(s) **841**" when described without any particular differentiation.

LED drive circuit **841***a* supplies drive signal **851***a* having preset current value I_a to one LED **310***a* as a current supplying section. LED drive circuit **841***b* supplies drive signal **851***b* having current value I_b to one LED **310***b* as a current supplying section. LED drive circuit **841***c* supplies drive signal **851***c* having current value I_c to one LED **310***c* as a current supplying section. LED drive circuit **841***d* supplies drive signal **851***d* having current value I_d to one LED **310***d* as a current supplying section. LED drive circuit **841***e* supplies drive signal **851***e* having current value I_e to one LED **310***e* as a current supplying section. LED drive circuit **841***f* supplies drive signal **851***f* having current value I_f to one LED **310***f* as a current supplying section.

Although not shown in FIG. **17**A, LED drive section **840** has the same number of LED drive circuits **841** (as current supplying sections) as LEDs **310**. Each LED drive circuit **841** supplies a drive signal to one LED **310**. By means of this configuration, each LED **310***a* is supplied with drive signal **851***a* having current value I_a, each LED **310***b* is supplied with drive signal **851***b* having current value I_b, each LED **310***c* is supplied with drive signal **851***c* having current value I_c, each LED **310***d* is supplied with drive signal **851***d* having current value I_d, each LED **310***e* is supplied with drive signal **851***e* having current value I_e, and each LED **310***f* is supplied with drive signal **851***f* having current value I_f.

Here, current value I_a is smaller than current value I_b, current value I_b is smaller than current value I_c, current value I_c is smaller than current value I_d, current value I_d is smaller than current value I_e, and current value I_e is smaller than current value I_f. Drive signals **851***a*, **851***b*, **851***c*, **851***d*, **851***e*, and **851***f* all have the same duty cycle.

That is to say, among LEDs **310**, those placed higher up and located nearer liquid crystal driver **752** are supplied with a lower current.

The current value of each LED **310** is set optimally based on the temperature distribution in surface area **601** of LED backlight **600**. For example, in an area (for example, area **601***a*) shown as a high-temperature area in the temperature distribution for a reason such as being located comparatively high up, or being located comparatively near liquid crystal driver **752**, an LED **310** current value is set comparatively low. And in an area (**601***c*) shown as a low-temperature area in the temperature distribution for a reason such as being located comparatively low down, or being located comparatively far from liquid crystal driver **752**, an LED **310** current value is set comparatively high. These settings are made in such a way that the junction temperature becomes equal in all LEDs **310**.

By this means, among LEDs **310**, those placed higher up and located nearer liquid crystal driver **752** emit light at lower brightness. When this kind of drive control is performed, a difference in brightness may occur between individual LEDs **310**. However, since the junction temperatures of all LEDs **310** are equal, no difference in aging degradation progress occurs between individual LEDs **310**. Therefore, even if there is a difference in brightness between LEDs **310**, such a balance of brightness is maintained unchanged over a long period.

Also, among LEDs **310**, those placed higher up, located nearer liquid crystal driver **752**, and supplied with a lower current, are placed with higher density adjacent to another LED **310**.

Also, with LED backlight **600**, the lower the placement density of a position, the greater is the distance from LEDs **310** to diffuser plate **330**, and the wider is the diffusion of light that is emitted from a light source and is input upon diffuser plate **330**. By this means, an irradiated area in the inputting surface of diffuser plate **330** increases, enabling nonuniformity of brightness in the outputting surface of diffuser plate **330** to be reduced.

By this means, uniformity of brightness is realized over the entire area of the display screen, and is maintained unchanged over a long period.

It is possible to obtain the same kind of effect by making current values I the same, making the duty cycle of drive signal **851***a* smaller than that of drive signal **851***b*, making the duty cycle of drive signal **851***b* smaller than that of drive signal **851***c*, making the duty cycle of drive signal **851***c* smaller than that of drive signal **851***d*, making the duty cycle of drive signal **851***d* smaller than that of drive signal **851***e*, and making the duty cycle of drive signal **851***e* smaller than that of drive signal **851***f*.

Next, the brightness correction method used in liquid crystal display apparatus **800** will be described.

FIG. **18** is a drawing for explaining the brightness correction method used in liquid crystal display apparatus **800**.

Here, a case is described by way of example in which the ambient temperature of an area located higher up becomes higher during LED **310** illumination.

LEDs **310** are placed with higher density the higher their placement position. Simply by employing this kind of LED placement, a difference in a decrease in LED **310** brightness due to a difference in ambient temperature can be corrected, and brightness can be made uniform over the entire area of the display screen. This is possible even if drive signals with the same current value are supplied to all LEDs **310**.

However, in this embodiment, LED placement is decided in such a way that supposing that drive signals with the same current value are supplied to all LEDs **310**, brightness is higher in an area higher up in the display screen. Thus, when this kind of LED placement is employed, LEDs **310** are supplied with a lower current the higher their placement position. By this means, brightness in the LED **310***a* illumination area (that is, the area of the display screen illuminated by light emitted from all LEDs **310***a*), brightness in the LED **310***b* illumination area, brightness in the LED **310***c* illumination area, brightness in the LED **310***d* illumination area, brightness in the LED **310***e* illumination area, and brightness in the LED **310***f* illumination area, become uniform.

According to the brightness correction method shown in FIG. **18**, the same kind of effect can be realized as described in detail with reference to FIG. **5**A and FIG. **5**B in Embodiment 1.

Therefore, according to this embodiment, a lower current is supplied to LEDs **310** placed in an area with a higher ambient temperature within surface area **601** of substrate **320** of LED backlight **600**. By this means, the progress of aging degradation of all LEDs **310** provided in LED backlight **600** is made uniform. Therefore, the balance of brightness over the entire area of the display screen can be maintained over a long period. Also, according to this embodiment, control to slow aging degradation (that is, supply of a relatively low current) is performed for those of LEDs **310** for which aging degradation should be relatively rapid due to a relatively high ambient temperature. Therefore, the life of LED backlight **600** can be prolonged.

Also, according to this embodiment, the lower the placement density of a position, the greater is the distance between LEDs **310** and diffuser plate **330**. By this means, nonuniformity of brightness in the outputting surface of diffuser plate **330** can be reduced even if a configuration is employed that prolongs the life of LED backlight **600** by varying the placement density, as described above.

In this embodiment, a case has been described by way of example in which the ambient temperature of an area higher up is higher, and a configuration has been described in which LEDs **310** placed in an area higher up are placed with higher density, and are driven by a lower current. However, other configurations are also possible.

For example, if liquid crystal driver **752** is placed in proximity to the lower edge of liquid crystal panel **751**, so that the ambient temperature of a lower area becomes higher than that of an area above, a configuration can be employed in which LEDs **310** placed in a lower area are placed with higher density, and are driven by a lower current. With this configuration, provision should be made for the distance between LEDs **310** and diffuser plate **330** to be greater the higher up an area is.

Also, if liquid crystal driver **752** is placed in proximity to the left-hand edge of liquid crystal panel **751**, so that the ambient temperature of an area to the left becomes higher than that of an area to the right, a configuration can be employed in which LEDs **310** placed in an area to the left are placed with higher density, and are driven by a lower current. With this configuration, provision should be made for the distance between LEDs **310** and diffuser plate **330** to be greater the farther to the right an area is.

Also, if liquid crystal driver **752** is placed in proximity to the right-hand edge of liquid crystal panel **751**, so that the ambient temperature of an area to the right becomes higher than that of an area to the left, a configuration can be employed in which LEDs **310** placed in an area to the right are placed with higher density, and are driven by a lower current. With this configuration, provision should be made for the distance between LEDs **310** and diffuser plate **330** to be greater the farther to the left an area is.

Essentially, when the ambient temperature of an area near liquid crystal driver **752** becomes higher than the ambient temperature of an area farther away, a configuration can be employed in which LEDs **310** placed in the former area are placed with higher density, and are driven by a lower current.

Exactly the same applies to a power supply section—that is, power supply circuitry supplying power to liquid crystal driver **752**, LED drive circuits **841**, and so forth—and to other heat-generating members, as to liquid crystal driver **752**. This is because a power supply section and the like also generate heat. Thus, the placement, drive current values, and light source distances of LEDs **310** can be decided according to the placement positions of a power supply section and so forth.

Even if there is temperature distribution such that the ambient temperature of an area higher up does not become higher due to the internal structure of liquid crystal display apparatus **800**, the placement, drive current values, and light source distances of LEDs **310** can still be decided based on that temperature distribution.

In this embodiment, LEDs **310** are white LEDs, but the same kind of effect as described above can also be realized if LEDs **310** are a combination of LEDs of three colors—R (red), G (green), and B (blue). In this case, a configuration is employed in which more red LEDs, which decrease greatly in brightness due to temperature, are placed in a high-temperature area than green or blue LEDs. By this means, the color temperature balance can also be maintained over a long period.

If illumination of LED backlight **600** is interlinked with a liquid crystal panel **751** screen display scan and a backlight scan is performed to improve liquid crystal moving image performance, it is necessary to take account of the fact that the pitch differs in the LED vertical direction, and perform control of the LED backlight **600** illumination start time interlinked with the scan.

Embodiment 9

FIG. **19**A and FIG. **19**B are drawings showing the configuration of an LED backlight (backlight apparatus) according to Embodiment 9 of the present invention. FIG. **19**A is a schematic front view of the LED backlight, and FIG. **19**B is a schematic side view of the LED backlight. This embodiment relates, for example, to an LED backlight that is used as a backlight in a liquid crystal display and is configured so that brightness at the top of the screen is made particularly high when the liquid crystal display is set up so that screen is vertical. A vertical direction in FIG. **19**A and FIG. **19**B corresponds to a vertical direction when the liquid crystal display apparatus in which the LED backlight is used is set up—that is, the vertical direction of the screen.

In FIG. **19**A and FIG. **19**B, LED backlight **900** has a plurality of types of LEDs **910-1** through **910-6**, substrate **920** on which LEDs **910-1** through **910-6** are placed, and diffuser plate **930** placed on the light emitting side of LEDs **910-1** through **910-6**, as main components. LEDs **910-1** through **910-6** are white LEDs, for example. Substrate **920** is a flat printed circuit board using a material having insulating properties, such as glass epoxy resin. Diffuser plate **930** is a flat acrylic sheet, having inputting surface **931** upon which light emitted from plurality of LEDs **910** is input, and outputting surface **932** placed opposite inputting surface **931**. Diffuser plate **930** diffuses light input upon inputting surface **931** by means of surface diffusion, internal diffusion, or a combination thereof, and outputs light from outputting surface **932**.

Substrate **920** is placed parallel to diffuser plate **930**. LEDs **910-1** through **910-6** have lenses for controlling the light distribution characteristics of emitted light. LEDs **910-1** through **910-6** are placed in that order starting from the top of the drawing, and are placed with progressively greater density in the upward direction. Also, LEDs **910-1** through **910-6** are placed in such a way that light distribution gradually becomes wider in that order. That is to say, the lower the placement density of LEDs **910**, the wider is their light distribution. Here, "having a wide light distribution" means that the spread distribution of emitted light is wide. Light distribution characteristics are set arbitrarily by adjustment of the shape or refractive power of the LED **910** lenses, for example.

An example of numeric values when the placement density of LEDs **910-1** located at the top is designated Dh, the placement density of LEDs **910-6** located at the bottom is designated Dl, and the distance from LEDs **910** to inputting surface **931** of diffuser plate **930** (the light source distance) is designated T, is shown below.

Dh=0.0064 [units/mm^2] (average pitch with square placement: 12.5 mm)

Dl=0.0016 [units/mm^2] (average pitch with square placement: 20 mm)

T=10 [mm]

With the above example of numeric values, the average pitch of LEDs **910-6** located at the bottom is 1.6 times wider than the average pitch of LEDs **910-1** located at the top.

FIG. **20** is a drawing comparing the illuminance of emitted light of LEDs **910-1** with the illuminance of emitted light of LEDs **910-6**. In FIG. **20**, the horizontal axis indicates a coordinate [mm] on inputting surface **931** of diffuser plate **930**, and the vertical axis indicates a relative value corresponding to illuminance in the optical axis of the respective LEDs **910**.

As shown in FIG. **20**, when spread distribution **911** of emitted light of LEDs **910-1** is compared with spread distribution **912** of emitted light of LEDs **910-6**, spread distribution **912** of emitted light of LEDs **910-6** is 1.6 times wider than spread distribution **911** of emitted light of LEDs **910-1**.

Thus, in this embodiment, the ratio between the average pitches of LEDs **910-1** and LEDs **910-6**, and the ratio between the average spread distributions of LEDs **910-1** and LEDs **910-6**, are both 1.6, and have nearly matching configurations. That is to say, the spread distribution of light is in accordance with the placement density of LEDs **910**. Therefore, nonuniformity of brightness in inputting surface **931** of diffuser plate **930** can be reduced.

Also, since there is no particular influence on the external shape of the LED backlight **900** apparatus, a liquid crystal display apparatus using LED backlight **900** is advantageous in terms of design characteristics and production costs.

In this embodiment, a configuration has been described in which the ratio between the average pitches of LEDs **910-1** and LEDs **910-6**, and the ratio between the average spread distributions of LEDs **910-1** and LEDs **910-6**, are both 1.6, but this embodiment is not limited to this. Essentially, it is sufficient for a configuration to provide approximate coincidence between the average pitch ratio of LEDs **910** and the average spread distribution ratio of LEDs **910**.

In this embodiment, the high/low placement density variation trend of LEDs **910** is not limited to what has been described above. For example, in a case in which placement density becomes progressively higher in the downward direction of diffuser plate **930**, nonuniformity of brightness can be similarly reduced by selecting types of LEDs **910** so that light distribution becomes wider the lower the placement density of a position.

Embodiment 10

As Embodiment 10 of the present invention, an LED backlight will be described that provides for control of the amount of luminescence of LEDs.

FIG. **21** is a schematic configuration diagram drawing showing the configuration of an LED backlight according to Embodiment 10 of the present invention.

In FIG. **21**, LED backlight **1000** has a plurality of LEDs **910** placed with uniform placement density in the horizontal direction and with nonuniform placement density in the vertical direction. That is to say, the LED **910** placement density distribution is of the same kind as in Embodiment 9. Also, LED backlight **1000** has LED drive section **1040** that controls the amount of luminescence of plurality of LEDs **910**.

Taking a plurality of LEDs **910** aligned in the horizontal direction as one block, LED drive section **1040** controls the amount of luminescence of each LED **910** on a block-by-block basis according to an input control signal.

By means of this kind of configuration, control of the amount of luminescence of LEDs **910** can be performed in a manner appropriate to the LED **910** placement density distribution, and a desired brightness distribution can be obtained efficiently.

Embodiment 11

As Embodiment 11 of the present invention, a liquid crystal display apparatus will be described that uses an LED backlight according to Embodiment 10.

FIG. **22** is a schematic configuration diagram showing the configuration of a liquid crystal display apparatus according to Embodiment 11 of the present invention.

In FIG. **22**, liquid crystal display apparatus **1100** has LED backlight **1000** according to Embodiment 10 and liquid crystal unit **1150**. Components identical to those in FIG. **21** are assigned the same reference codes as in FIG. **21**, and descriptions thereof are omitted here.

Liquid crystal unit **1150** is illuminated by LED backlight **1000**, and controls the arrival on the observer's side of light emitted from LED backlight **1000**. Liquid crystal unit **1150** has liquid crystal panel **1151** and liquid crystal driver **1152**.

Liquid crystal panel **1151** is a transmissive or semi-transmissive liquid crystal panel. Liquid crystal panel **1151** transmits light emitted from LED backlight **1000**, and emits this transmitted light from the front surface of the display screen.

Liquid crystal driver **1152** controls a drive voltage that drives liquid crystal panel **1151** based on a video signal that is a digital signal indicating video to be displayed on the display screen of liquid crystal panel **1151**, and thereby controls the transmittance of liquid crystal panel **1151**. As a result of this control, liquid crystal panel **1151** displays video.

LED backlight **1000** controls the amount of luminescence of LEDs **910** on a block-by-block basis as described in Embodiment 10. On the other hand, light transmittance cannot be made zero for liquid crystal panel **1151**. Therefore, by minimizing the amount of luminescence of LEDs **910** on a block-by-block basis, black brightness—the brightness of a black display part of the screen—can be reduced, and an improvement in screen contrast can be achieved.

Thus, according to this embodiment, video having a desired brightness distribution without nonuniformity of brightness can be displayed with a high degree of contrast, and power consumption can be reduced.

In the above-described embodiments, cases have been described in which a light source is an LED, but the present invention is not limited to this. For example, the present invention can also be applied to cases in which light sources are of various kinds, such as a semiconductor laser, gas laser, solid-state laser, fiber laser, lamp, and so forth, and various kinds of line light sources of a cathode ray tube or the like are placed with nonuniform distribution.

Embodiment 12

As Embodiment 12 of the present invention, a liquid crystal display apparatus that is distinctive in regard to liquid crystal driver placement and operation of the LED drive section will be described.

FIG. **23** is a side view of the principal parts of a liquid crystal display apparatus according to Embodiment 12 of the present invention, and corresponds to FIG. **19**B of Embodiment 9 and FIG. **22** of Embodiment 11. Components identical to those in FIG. **19**B and FIG. **22** are assigned the same reference codes as in FIG. **19**B and FIG. **22**, and descriptions thereof are omitted here.

Liquid crystal display apparatus **1200** has liquid crystal panel **1151**, liquid crystal driver **1152**, and LED backlight **1000** as main components.

In this embodiment, liquid crystal driver **1152** is placed in proximity to the upper edge of liquid crystal panel **1151**.

Liquid crystal driver **1152** may also be placed in a location other than the above. For example, liquid crystal driver **1152** may be placed in proximity to the lower edge, left-hand edge, or right-hand edge of liquid crystal panel **1151**, or may be placed elsewhere.

In LED backlight **1000**, substrate **920** is placed opposite diffuser plate **930** placed on the rear surface side of liquid crystal panel **1151**, in the same way as in Embodiment 9. The surface of substrate **920** is an opposed section opposite the rear surface of liquid crystal panel **1151**, and LEDs **910***a*, **910***b*, **910***c*, **910***d*, **910***e*, and **910***f* are arrayed on this surface in approximately flat form facing the rear surface of diffuser plate **930**. Diffuser plate **930** has a diffusing action on the input light, and outputs light from the outputting surface toward the rear surface of liquid crystal panel **1151**. That is to say, LED backlight **1000** is a subjacent type of LED backlight.

Generally, a subjacent type of LED backlight has a sealed structure that can prevent the infiltration of dust or dirt, but LED backlight **1000** may or may not employ a sealed structure.

LED backlight **1000** illuminates liquid crystal panel **1151** with light emitted from LEDs **910***a*, **910***b*, **910***c*, **910***d*, **910***e*, and **910***f*. In the following description, LEDs **910***a*, **910***b*, **910***c*, **910***d*, **910***e*, and **910***f* are referred to simply as "LED(s) **910**" when described without any particular differentiation.

LED backlight **1000** also has an LED drive section that drives LEDs **910**, described later herein.

Here, LEDs **910** are white LEDs that emit white light when driven by a drive signal applied from an LED drive section described later herein. For example, when LEDs **910** are LED apparatuses having mainly a monochromatic (for example, blue) LED and a fluorescent material, LEDs **910** are configured so that light emitted from a monochromatic LED when a drive signal is applied is transmitted through the fluorescent material and becomes white light through the action of the fluorescent material.

LEDs **910** may also employ another configuration, such as a combination of LEDs of three colors—R (red) G (green), and B (blue).

FIG. **24** is a drawing showing the placement of LEDs **910** in LED backlight **1000**.

LEDs **910** placed in area **1001***a* located at the top are placed most densely, LEDs **910** placed in area **1001***c* located at the bottom are placed least densely, and LEDs **910** placed in area **1001***b* located in the middle are placed with medium density. To be more specific, in the vertical direction, pitch d_{ab} between LED **910***a* and LED **910***b* is smaller than pitch d_{bc} between LED **910***b* and LED **910***c*, pitch d_{bc} is smaller than pitch d_{cd} between LED **910***c* and LED **910***d*, pitch d_{cd} is smaller than pitch d_{de} between LED **910***d* and LED **910***e*, and pitch d_{de} is smaller than pitch d_{ef} between LED **910***d* and LED **910***f*. Also, in the horizontal direction, the pitch of LEDs **910***a* is smaller than the pitch of LEDs **910***b*, the pitch of LEDs **910***b* is smaller than the pitch of LEDs **910***c*, the pitch of LEDs **910***c* is smaller than the pitch of LEDs **910***d*, the pitch of LEDs **910***d* is smaller than the pitch of LEDs **910***e*, and the pitch of LEDs **910***e* is smaller than the pitch of LEDs **910***f*.

LEDs **910** have a configuration such that emitted light is diffused progressively more widely in the downward direction in the drawing.

FIG. **25**A and FIG. **25**B are drawings for explaining an LED drive section in LED backlight **1000**. FIG. **25**A is a circuit diagram showing an example of the configuration of the LED drive section, and FIG. **25**B is a waveform diagram showing an example of drive signals generated by the LED drive section and supplied to LEDs **910**.

LED drive section **1240** has LED drive circuits **1241***a*, **1241***b*, **1241***c*, **1241***d*, **1241***e*, and **1241***f*. In the following description, LED drive circuits **1241***a*, **1241***b*, **1241***c*, **1241***d*, **1241***e*, and **1241***f* are referred to simply as "LED drive circuit (s) **1241**" when described without any particular differentiation.

LED drive circuit **1241***a* supplies drive signal **1251***a* having preset current value I_a to one LED **910***a* as a current supplying section. LED drive circuit **1241***b* supplies drive signal **1251***b* having current value I_b to one LED **910***b* as a current supplying section. LED drive circuit **1241***c* supplies drive signal **1251***c* having current value I_c to one LED **910***c* as a current supplying section. LED drive circuit **1241***d* supplies drive signal **1251***d* having current value I_d to one LED **910***d* as a current supplying section. LED drive circuit **1241***e* supplies drive signal **1251***e* having current value I_e to one LED **910***e* as a current supplying section. LED drive circuit **1241***f* supplies drive signal **1251***f* having current value I_f to one LED **910***f* as a current supplying section.

Although not shown in FIG. **25**A, LED drive section **1240** has the same number of LED drive circuits **1241** (as current supplying sections) as LEDs **910**. Each LED drive circuit **1241** supplies a drive signal to one LED **910**. By means of this configuration, each LED **910***a* is supplied with drive signal **1251***a* having current value I_a, each LED **910***b* is supplied with drive signal **1251***b* having current value I_b, each LED **910***c* is supplied with drive signal **1251***c* having current value I_c, each LED **910***d* is supplied with drive signal **1251***d* having current value I_d, each LED **910***e* is supplied with drive signal **1251***e* having current value I_e, and each LED **910***f* is supplied with drive signal **1251***f* having current value I_f.

Here, current value I_a is smaller than current value I_b, current value I_b is smaller than current value I_c, current value I_c is smaller than current value I_d, current value I_d is smaller than current value I_e, and current value I_e is smaller than current value I_f. Drive signals **1251***a*, **1251***b*, **1251***c*, **1251***d*, **1251***e*, and **1251***f* all have the same duty cycle.

That is to say, among LEDs **910**, those placed higher up and located nearer liquid crystal driver **1152** are supplied with a lower current.

The current value of each LED **910** is set optimally based on the temperature distribution in surface area **1001** of LED backlight **1000**. For example, in an area (for example, area **1001***a*) shown as a high-temperature area in the temperature distribution for a reason such as being located comparatively high up, or being located comparatively near liquid crystal driver **1152**, an LED **910** current value is set comparatively low. And in an area (**1001***c*) shown as a low-temperature area in the temperature distribution for a reason such as being located comparatively low down, or being located comparatively far from liquid crystal driver **1152**, an LED **910** current value is set comparatively high. These settings are made in such a way that the junction temperature becomes equal in all LEDs **910**.

By this means, among LEDs **910**, those placed higher up and located nearer liquid crystal driver **1152** emit light at lower brightness. When this kind of drive control is performed, a difference in brightness may occur between individual LEDs **910**. However, since the junction temperatures of all LEDs **910** are equal, no difference in aging degradation progress occurs between individual LEDs **910**. Therefore, even if there is a difference in brightness between LEDs **910**, such a balance of brightness is maintained unchanged over a long period.

Also, among LEDs **910**, those placed higher up, located nearer liquid crystal driver **1152**, and supplied with a lower current, are placed with higher density adjacent to another LED **910**.

Also, with LED backlight **1000**, the lower the placement density of a position, the wider is the diffusion of light that is emitted from LEDs **910**. By this means, an irradiated area in the inputting surface of diffuser plate **930** increases, enabling nonuniformity of brightness in the outputting surface of diffuser plate **930** to be reduced.

By this means, uniformity of brightness is realized over the entire area of the display screen, and is maintained unchanged over a long period.

It is possible to obtain the same kind of effect by making current values I the same, making the duty cycle of drive signal **1251***a* smaller than that of drive signal **1251***b*, making the duty cycle of drive signal **1251***b* smaller than that of drive signal **1251***c*, making the duty cycle of drive signal **1251***c* smaller than that of drive signal **1251***d*, making the duty cycle of drive signal **1251***d* smaller than that of drive signal **1251***e*, and making the duty cycle of drive signal **1251***e* smaller than that of drive signal **1251***f*.

Next, the brightness correction method used in liquid crystal display apparatus **1200** will be described.

FIG. **26** is a drawing for explaining the brightness correction method used in liquid crystal display apparatus **1200**. Here, a case is described by way of example in which the ambient temperature of an area located higher up becomes higher during LED **910** illumination.

LEDs **910** are placed with higher density the higher their placement position. Simply by employing this kind of LED placement, a difference in a decrease in LED **910** brightness due to a difference in ambient temperature can be corrected, and brightness can be made uniform over the entire area of the display screen. This is possible even if drive signals with the same current value are supplied to all LEDs **910**.

However, in this embodiment, LED placement is decided in such a way that supposing that drive signals with the same current value are supplied to all LEDs **910**, brightness is higher in an area higher up in the display screen. Thus, when this kind of LED placement is employed, LEDs **910** are supplied with a lower current the higher their placement position. By this means, brightness in the LED **910***a* illumination area (that is, the area of the display screen illuminated by light emitted from all LEDs **910***a*), brightness in the LED **910***b* illumination area, brightness in the LED **910***c* illumination area, brightness in the LED **910***d* illumination area, brightness in the LED **910***e* illumination area, and brightness in the LED **910***f* illumination area, become uniform.

According to the brightness correction method shown in FIG. **26**, the same kind of effect can be realized as described with reference to FIG. **5**A and FIG. **5**B in Embodiment 1.

Therefore, according to this embodiment, a lower current is supplied to LEDs **910** placed in an area with a higher ambient temperature within surface area **1001** of substrate **920** of LED backlight **1000**. By this means, the progress of aging degradation of all LEDs **910** provided in LED backlight **1000** is made uniform. Therefore, the balance of brightness over the entire area of the display screen can be maintained over a long period. Also, according to this embodiment, control to slow aging degradation (that is, supply of a relatively low current) is performed for those of LEDs **910** for which aging degradation should be relatively rapid due to a relatively high ambient temperature. Therefore, the life of LED backlight **1000** can be prolonged.

Also, according to this embodiment, the lower the placement density of a position, the wider is the diffusion of light that is emitted from LEDs **910**. By this means, nonuniformity of brightness in the outputting surface of diffuser plate **930** can be reduced even if a configuration is employed that achieves longer life by varying the placement density, as described above.

In this embodiment, a case has been described by way of example in which the ambient temperature of an area higher up is higher, and a configuration has been described in which LEDs **910** placed in an area higher up are placed with higher density, and are driven by a lower current. However, other configurations are also possible.

For example, if liquid crystal driver **1152** is placed in proximity to the lower edge of liquid crystal panel **1151**, so that the ambient temperature of a lower area becomes higher than that of an area above, a configuration can be employed in which LEDs **910** placed in a lower area are placed with higher density, and are driven by a lower current. With this configuration, provision should be made for light emitted from LEDs **910** to be diffused more widely the higher up an area is.

Also, if liquid crystal driver **1152** is placed in proximity to the left-hand edge of liquid crystal panel **1151**, so that the ambient temperature of an area to the left becomes higher than that of an area to the right, a configuration can be employed in which LEDs **910** placed in an area to the left are placed with higher density, and are driven by a lower current. With this configuration, provision should be made for light emitted from LEDs **910** to be diffused more widely the farther to the right an area is.

Also, if liquid crystal driver **1152** is placed in proximity to the right-hand edge of liquid crystal panel **1151**, so that the ambient temperature of an area to the right becomes higher than that of an area to the left, a configuration can be employed in which LEDs **910** placed in an area to the right are placed with higher density, and are driven by a lower current.

With this configuration, provision should be made for light emitted from LEDs **910** to be diffused more widely the farther to the left an area is.

Essentially, when the ambient temperature of an area near liquid crystal driver **1152** becomes higher than the ambient temperature of an area farther away, a configuration can be employed in which LEDs **910** placed in the former area are placed with higher density, and are driven by a lower current.

Exactly the same applies to a power supply section—that is, power supply circuitry supplying power to liquid crystal driver **1152**, LED drive circuits **1241**, and so forth—and to other heat-generating members, as to liquid crystal driver **1152**. This is because a power supply section and the like also generate heat. Thus, the placement, drive current values, and light source distances of LEDs **910** can be decided according to the placement positions of a power supply section and so forth.

Even if there is temperature distribution such that the ambient temperature of an area higher up does not become higher due to the internal structure of liquid crystal display apparatus **1200**, the placement, drive current values, and light source distances of LEDs **910** can still be decided based on that temperature distribution.

In this embodiment, LEDs **910** are white LEDs, but the same kind of effect as described above can also be realized if LEDs **910** are a combination of LEDs of three colors—R (red), G (green), and B (blue). In this case, a configuration is employed in which more red LEDs, which decrease greatly in brightness due to temperature, are placed in a high-temperature area than green or blue LEDs. By this means, the color temperature balance can also be maintained over a long period.

If illumination of LED backlight **1000** is interlinked with a liquid crystal panel **1151** screen display scan and a backlight scan is performed to improve liquid crystal moving image performance, it is necessary to take account of the fact that the pitch differs in the LED vertical direction, and perform control of the LED backlight **1000** illumination start time interlinked with the scan.

This concludes a description of embodiments of the present invention.

The above descriptions are illustrations of preferred embodiments of the present invention, and the scope of the present invention is not limited to these. That is to say, the configurations and operations during use of the above-described apparatuses are simply examples, and it is clearly possible to make various modifications and additions to these examples without departing from the scope of the present invention.

What is claimed is:

1. A backlight apparatus that is used in a liquid crystal display apparatus having a liquid crystal panel as a display screen, the backlight apparatus comprising:

a substrate having an opposed section placed opposite a rear surface side of the liquid crystal panel;

a plurality of light emitting diodes placed with nonuniform placement density on the opposed section;

a diffuser plate upon which light emitted from the plurality of light emitting diodes is input and that has a diffusing action on the input light and outputs diffused light toward the liquid crystal panel side; and

a current supplying section that supplies to the plurality of light emitting diodes a current that causes the plurality of light emitting diodes to emit light that illuminates the liquid crystal panel, wherein:

the current supplying section supplies a lower current to a light emitting diode placed in an area having a higher ambient temperature within an area of the opposed section;

a light emitting diode to which a lower current is supplied is placed with higher density adjacent to another light emitting diode; and

a distance between the opposed section and the diffuser plate is greater the lower the placement density of a position.

2. A liquid crystal display apparatus comprising:

the backlight apparatus according to claim **1**; and

a liquid crystal panel that controls arrival on an observer's side of light emitted from the diffuser plate.

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